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NATIVE CALIFORNIA RODENTS IN RELATION TO WATER SUPPLY

BY JOSEPH GRINNELL

No advanced student of mammalian natural history should content himself short of seeking implications and explanations in various related directions far beyond the immediate limits of his own special field of observation. Indeed, he cannot afford, any more than any other scientific student can, to limit himself narrowly, even if in order only to equip himself better to handle his own investigations. And when such radial enquiries lead to ideas which seem to bear significantly upon questions of the day, especially those that have to do with human welfare, then would he be positively remiss if he did not make known the practical bearings that may have suggested themselves to him.

The most important economic consideration in California today is maintenance and improvement of conditions favorable for human occupation, including continuation of agriculture in the truly arable parts of the state, those that lie in the lowlands and larger valleys. The greatest prerequisite factor in this regard is all-year water supply to those lowland areas. But the water supply to the lowlands is not adequate for present human needs, or not suitably distributed, and its available volume, at least in the southern parts of the state, has been diminishing. This trend, it now appears, is in part because of certain destructive man-caused factors.

There are three of these factors which have made for progressive reduction of water supply and hence reduction of potential agricultural output; namely, devastating fires, excessive grazing, and cultivation of submarginal lands. In final analysis, each of these processes does the

most lasting harm by reducing or completely removing the vegetational cover; for the presence of the normal, original, vegetational cover, I believe, conditions the greatest longtime benefits and least harm from the periodic rainfall and snowfall. Vegetational cover prevents quick run-off and abnormal slope erosion, which lead to floods and to destruction of arable lands at lower levels. The surface litter makes for speedy absorption of water into the ground and hence for greater water storage and ultimate gradual yield of water throughout the dry season *via* springs, sustained stream-flow, and heightened water-tables. And, perhaps above all else, absorption is favored by the presence of ground-cover, in that by impeding the air currents it prevents the rapid loss of water by evaporation and by plant transpiration in this climate where the rains are regularly followed by dry spells, when the terrain is swept by desiccating winds.

Maintenance of the natural cover on California's watersheds appears to be dependent upon the persistence of the complex of conditions under which it has been built up by intricate processes of adjustment through the ages. Present destructive trends can be arrested by reduction to the practical minimum of those baneful man-caused factors mentioned—fire, grazing and submarginal farming. Furthermore, recovery of the damaged slopes, already vast in total area, can be favored by allowing to operate, unhindered, those natural processes which, *under the special conditions of climate and topography in California*, can alone be depended upon to bring back optimum conditions of the native vegetational cover. Such processes of recovery can, of course, only be slow in terms of years; but they have brought the optimum results in the past and can, therefore, it is here held, be relied upon for the future. The primary "use" of California's uplands will always be water-production for the lowlands.

Among the complex of factors favorable to the persistence, and also to the recovery, of our superlatively valuable plant cover is the associated native animal life. Naturalists agree as to the existence of intricate interdependencies between the components of the established biotic community. It is my purpose here to point out one of these chains of interdependence, pertaining to one group of animals, and which from my own field observation seems manifestly vital to the welfare of the native vegetational cover. The major group of animals here to be cited comprises the vertebrates; among these are the rodents which by species as well as by individuals constitute far more than half the native mammalian population of California.

I would particularly emphasize the importance of *rodents which burrow*. These animals, characteristically so numerous in a region marked by a long dry season and a brief rainy one, render service to the plant cover primarily through their agency as natural cultivators of the soil. Their presence brings to the native plants associated with them quite the same sorts of effects as the farmer produces by his "artificial" cultivation of the crops he raises. And the rodents, be it noted, likewise take pay, in the form of seeds, fruits, leaves, stems and roots—but rarely, be it further remarked, under normal inter-relations, to a point anywhere near appropriation of the entire crop.

There is good observational and inferential basis for recognizing that the native rodent burrowers on our watersheds contribute to the optimum welfare of the plant cover in certain definite ways, as follows:

(1) Weathering of the substratum is promoted by the burrow systems, which carry air and water with contained solvents to the subsoil and rock masses below. By their presence through long time, the deepening of the soil is hastened.

(2) Subsoil is comminuted and brought to the surface where, spread out thinly by action of wind and rain, it is exposed to further weathering and is incorporated with the top soil.

(3) The activities of burrowing rodents on ground that is not overgrazed tend to prevent catastrophic erosion. During heavy storms or rapid thaws the burrows form entry ways for the water, leading it into the porous ground for further slow distribution there; and the mounds, notably those on the steeper slopes, are of such construction as to constitute veritable systems of terracing.

(4) Much vegetable matter is carried by the rodents into their burrow systems where it contributes to form the organic content which characterizes the more productive soils. Also the surface accumulation of vegetable débris tends to be buried by the earth brought from below and this makes further for humus formation.

(5) The burrowing activities of rodents are known in certain places to increase the supply of available nitrogen and other important chemical substances in the soil required for plant use. This effect is probably very general.

(6) The mere mechanical loosening of the ground through the activities of burrowing animals makes for thrifty plant growth. Their presence helps to compensate for the packing effect of tramping by heavy-bodied mammals. The impact of many feet on the soil, especially when the soil is wet, greatly reduces or even extinguishes herbaceous growth on

such ground. One has but to look at conditions on mountain meadows within, and outside of, National Parks or other areas reserved from grazing to appreciate this point.

(7) To a considerable degree, perhaps essentially in the cases of some important cover-plants, and even forest trees, the function of seeding under the most favorable conditions for successful germination is probably performed mainly by rodents.

It may be said, then, with considerable measure of confidence, that on wild, uncultivated lands, especially those comprised in our watersheds, the rodents are among the necessary factors in the well-being of the ground-cover, whether it be sodded grass, chaparral of one type or another, or true forest more or less approaching its climax development.

But I must not limit the biotic interrelationship picture just here. There is the great importance of the native *carnivorous* mammal population in stabilizing the numbers of rodents—in preventing sporadic overdraft by them upon the plant cover. Biological control, automatically applied, is provided for by the carnivore factor.

I am one of those who believe in what has been termed the "balance of nature," but in the special sense that this is a condition among associated plants and animals wherein a complete adjustment of numbers and species is continually being approached under great biotic pressure but, paradoxically, *never is reached*. In age-long history, in the filling of ecological niches (biotopes), in the establishing of plant-and-animal communities, a condition of *relative* equilibrium comes about, recognizable over periods of years even though there be sharp fluctuations in included shorter periods of time. Here is where the importance of the carnivorous mammal comes in—importance to maintenance of water cover and also to most rapid rate of recovery of it after devastating fire or intemperate grazing.

Remove a natural check to unlimited increase of a vegetarian species of animal and the latter may quickly multiply inordinately, to the immediate upset of the preceding stage of balance, the exhaustion of immediate food supply (and often serious injury to those individual plants which are of the perennial sorts), the emigration of the animals, and at last the onset of disease with final near wiping out of their own species over a wide area. In other words, the presence and welfare of the carnivore level in the faunal superstructure is important in the long-time health of, or recovery of, the entire association, including the plants comprising the invaluable vegetational cover that conserves water. The fact that serious, human caused upsets of "balance" have occurred

is no good ground for interfering with the so-important re-setting process which naturally tends to ensue.

To sum up the present issue: Risk to the fundamental, agricultural interests of California is incurred by tampering with the "natural balance" as I here define it, which pertains normally to the plant-animal associations on our watersheds, indeed on uncultivated lands generally. Any widespread activity directed toward destroying the native burrowing rodents on such areas, or toward destroying the associated carnivorous animals which help regulate the population numbers of those rodents, can in my judgment only hasten the progressive depletion of the real, permanent values of our state, a depletion which is now recognized by many qualified observers, foresters as well as naturalists, latterly to have been under way.

Our concerted efforts should be to maintain, and to allow to come back wherever damaged, the natural conditions on our uplands. The above program constitutes the best working hypothesis known to me upon which to base correct action—upon which to avoid wrong action. It is the hypothesis that guides my judgment in this question of artificial "management," or "control," of wild animal life.

The best definition I have read of high civilization is the exhibition of the ability and the will most firmly to build in the present for the future. We must surely prefer to look forward to a time in California of greatest material advantage and intellectual enjoyment on the part of a stabilized human population. Will the lapse of a few hundred years find California in the condition of a Syrian desert, occupied by a few wretched nomads supported by some goats, or will the lowlands of California then comprise a continuingly fertile, prosperous country, supporting the highest type of human civilization?

Here, then, are vital questions upon which I believe the student of mammalian ecology can throw important light. No definite evidence is yet afforded adequate to final evaluation of all of the factors concerned. The experimental method, even applied over long time in terms of years, may prove insufficient for testing the true nature of certain processes. Comparative observation and rational inference may have to be relied upon in the future, and should be carried on and the results heeded now, in arriving at proper courses of action.

Some lately published papers very likely of interest to all mammalogists and dealing from one angle or another with points touched upon in the preceding paper are as follows. In some of these papers, many references to other pertinent literature will be found.

FORESTS AND STREAM FLOW: Hoyt and Troxell, Proc. Amer. Soc. Civil Engineers, vol. 58, Aug., 1932, pp. 1037–1066; Bates, *id.*, Sept., 1932, pp. 1288–1293; Stevens, Blaney, Mead, Randall, Barrows, Baker, Smead, and Cecil, *id.*, Dec., 1932, pp. 1811–1836; Sopp and Rowe, *id.*, vol. 59, Feb., 1933, pp. 376–379; Lowdermilk, Rule and Kennedy, *id.*, Mar., 1933, pp. 484–494.

GREENE, R. A., AND REYNARD, C. R. Influence of Two Burrowing Rodents. . . on Desert Soils in Arizona. Ecology, vol. 13, 1932, pp. 73–80. (See also Greene, R. A., and Murphy, G. H., *id.*, pp. 359–363.)

HINTON, M. A. C. Biological Principles in the Control of Destructive Animals. Proc. Linnean Soc. London, Session 144, 1931–32, pt. 4, 1932, pp. 111–126.

SHELFORD, V. E. Some Concepts of Bioecology. Ecology, vol. 12, 1931, pp. 455–467.

TAYLOR, W. P. Methods of Determining Rodent Pressure on the Range. Ecology, vol. 11, 1930, pp. 523–542. (See also Taylor, W. P., *id.*, pp. 787–788.)

Museum of Vertebrate Zoology, Berkeley, California.

FERTILITY RELATIONSHIPS BETWEEN SOME OF THE SPECIES AND SUBSPECIES OF MICE IN THE GENUS PEROMYSCUS

BY LEE R. DICE

The mice of the genus Peromyscus have proved quite generally fertile in the laboratory when pairs of the same stock are mated together. Some pairs during the breeding season will produce a litter with great regularity every month for 5 or 6 months or even for a longer period. However, some species and subspecies have proved to be only moderately fertile, while a few forms so far have failed entirely to reproduce in captivity.

For securing the breedings stocks used in this study I am indebted to Philip F. Allan, Seth Benson, Philip Blossom, G. W. Bradt, J. C. Cross, Dora S. Dice, Robert K. Enders, Julius Haverson, Paul Hickie, Arthur H. Howell, Ralph W. Jackson, M. F. Landwer, Paul A. Moody, Adolph Murie, H. B. Sherman, H. M. Smith, L. C. Stegeman, W. L. Strunk, Arthur and Ruth Svihla, W. V. Turnage, H. V. Williams, and especially to Francis B. Sumner. The studies have been supported by the Museum of Zoology and the Laboratory of Vertebrate Genetics of the University of Michigan, aided by grants from the Faculty Research Fund. The animals have been reared by the methods described in an earlier publication.[1]

[1] L. R. Dice, Journ. Mammalogy, vol. 10, pp. 116–124. 1929.

A description of reproduction in the mice of this genus has been given by Svihla.[2]

My method of making matings is to place the male and the female together in a freshly cleaned cage. Under conditions strange to both they are less likely to fight than if one be introduced into the cage of the other. Fighting does occur between some newly mated individuals, especially when the members of the pair are of different races, and sometimes one or both animals may be injured or killed. To secure harmonious matings between distinct species it is desirable to mate the animals when they are very young—weaning time is the best age. An old animal is likely to fight to the death if placed with an individual of another species. The mated pairs are left together constantly. The matings are considered to be failures if no young are produced in a period of four or more months during spring, summer, or autumn, which are the seasons of greatest sexual activity. However, many of the matings have been continued for a year or more.

Species of *Peromyscus* which have bred in my laboratory at Ann Arbor, Michigan, are *eremicus*, *californicus*, *maniculatus*, *polionotus*, *leucopus*, *gossypinus*, *boylii*, *nasutus*, *truei*, and *nuttallii*. Of these species, *boylii* has been generally a poor breeder, although one stock has been very fertile. The one female of *nuttallii* which I had available proved fertile, but the young did not live long, so that I failed to establish a continuing stock.

Peromyscus crinitus has failed to breed in the laboratory, but I have had only two pairs available, one pair of *P. c. auripectus* and one of *P.c. disparilis*. The species therefore has not had a fair trial.

Some subspecies also have failed to breed, even though closely related races have been fertile. Subspecies which so far have failed to breed in the laboratory are *Peromyscus maniculatus oreas*, *P. leucopus aridulus*, *P. l. tornillo*, and *P. boylii levipes*. All of these except *oreas* have been represented by few individuals. If larger numbers had been available it is probable that most or all the races would have bred.

Peromyscus maniculatus oreas has so far proved entirely infertile in my laboratory. Not a single young one has been produced by any of ten pairs kept together for considerably more than a year. The original stock was kindly secured for me by Arthur Svihla at Port Angeles, Washington. Svihla[3] secured young from the mating of a pair kept in a cage at the locality where they were taken; but when moved to a lab-

[2] A. Svihla, Univ. Mich., Misc. Publ. Mus. Zool., no. 24, pp. 1–39. 1932.

[3] Arthur Svihla, Murrelet, vol. 14, pp. 13–14. 1933.

oratory at Pullman, Washington, the whole stock became infertile. It should be remarked that Pullman is located in a rather arid prairie part of the state, while Port Angeles is in the dense coastal forest with heavy rainfall. Evidently some factor of importance to this subspecies is lacking from the laboratory environment both at Pullman and Ann Arbor, as these mice have bred at neither place.

Stocks of mice secured from different localities within the range of one subspecies frequently show considerable differences in their fertility. One stock of a subspecies may be very fertile while another stock is relatively infertile. Evidently fertility is not closely correlated with subspecific characters, most of which are based on body dimensions or on color.

Stocks represented by many individuals, and therefore allowing the making of many matings, are most likely to prove fertile. In a small stock a few infertile individuals may prevent most or all of the pairs from being fruitful.

Certain individuals in nearly every stock seem to be infertile. These may be either males or females. I cannot present statistics on this point for my general aim has been to secure large numbers of offspring for studies of variability, and little attempt has been made to test the fertility of each individual. In some stocks every pair will produce young, while in other stocks only an occasional pair will breed. When a pair does prove fertile it will often produce a number of litters in succession. The mice born in the laboratory are more likely to be fertile than those caught in the field.

The cause of the infertility of individual mice has not been investigated. Undoubtedly some individuals are past their most productive age when caught. Others are perhaps adversely affected by the change in mode of life necessitated by captivity.

A breeding season seems to occur in my laboratory, even though the temperature during the winter is kept quite uniformly slightly above 70°F. Relatively few young are born during the winter months from November to January. The food does not vary during the year; it is mostly a dry ration, with the addition of lettuce.

It is quite likely that our laboratory conditions favor some stocks and some subspecies more than others, for we would expect the various geographic races to have different requirements for temperature, humidity, food, and perhaps for other factors.

There is a possible suggestion of a differential fecundity in my laboratory between certain groups of subspecies within the species *maniculatus*. The subspecies *artemisiae*, *gracilis*, *hollisteri*, *maniculatus*, *oreas*, and

rubidus have in general proved to be less fertile than the subspecies *assimilis, bairdii, blandus, gambelii, osgoodi, rufinus,* and *sonoriensis.* However, certain pairs or even whole stocks of *artemisiae, gracilis, hollisteri,* and *rubidus* have been very fertile, while other pairs or even whole stocks of these subspecies have failed to produce any offspring. As was mentioned above, *oreas* has failed completely to breed in the laboratory.

It will be noted that the short-tailed subspecies of *maniculatus* are in general very fertile in the laboratory, while the long-tailed forms are much less productive. The short-tailed subspecies generally have a more southern range and usually live in prairies, deserts, and rather arid forests, though some live in quite heavy mountain-top forests. On the other hand, the long-tailed subspecies in general live in the heavy northern or Pacific coast forests. Apparently the conditions in my laboratory are most favorable for the short-tailed subspecies of more southern distribution.

Matings between different subspecies of one species are usually fertile, probably nearly as frequently as matings between individuals of the less fertile subspecies involved in the cross. The offspring of such subspecific crosses have proved to be fertile in every case tested.

Eleven subspecies of the deer-mouse *Peromyscus maniculatus* so far tested have all proved more or less fertile when crossed with other subspecies of the same species. These subspecies are *artemisiae, assimilis, bairdii, blandus, gambelii, gracilis, hollisteri, maniculatus, osgoodi, rubidus,* and *sonoriensis.* The several subspecific crosses have not all been equally productive, but it seems probable that every subspecies of this species is more or less fertile with every other subspecies.

In the beach-mouse, *Peromyscus polionotus,* Sumner[4] secured fertile offspring from all the possible crosses between three subspecies, *albifrons, leucocephalus,* and *polionotus.*

In the white-footed mouse, *Peromyscus leucopus,* I have secured fertile offspring between the subspecies *arizonae, fusus, leucopus, noveboracensis,* and *texanus.*

Two subspecies, *eremicus* and *fraterculus,* of the cactus-mouse, *Peromyscus eremicus,* produced fertile offspring when crossed by Huestis.[5] The subspecies *anthonyi, eremicus, fraterculus,* and *pullus*[6] have proved to be fertile together when crossed in my laboratory.

[4] F. B. Sumner, Journ. Genetics, vol. 23, p. 282. 1930.

[5] R. R. Huestis, Proc. Nat. Acad. Sci., vol. 9, p. 354. 1923.

[6] Philip M. Blossom, Univ. Michigan, Occas. Pap. Mus. Zool., no. 265, p. 3. 1933.

Of the pinyon-mouse, *Peromyscus truei*, the subspecies *gilberti* and *truei* have produced young when crossed.

Two subspecies, *californicus* and *insignis*, of the parasitic mouse, *Peromyscus californicus*, also have proved to be fertile when crossed.

The evidence from these crossings is that all the geographic races of one species are more or less fertile together in the laboratory. This does not prove that interbreeding will always occur in nature when two related subspecies occupy the same area. Instances of the failure of related subspecies to interbreed where they occur together have been reported by Adolph Murie[7] and by myself.[8] In both these instances the two subspecies concerned occupy different ecological habitats and this segregation is undoubtedly a factor in preventing their interbreeding.

Crosses in the laboratory between the closely related species *maniculatus* and *polionotus* have produced fertile young. Sumner,[9] out of a number of attempted crosses between *P. polionotus leucocephalus* and various subspecies of *maniculatus*, secured one female offspring in a cross with *P. m. sonoriensis*. This F_1 female proved to be fertile when mated with *gambelii*, another subspecies of *maniculatus*. In my laboratory one litter of young has been secured from 5 matings of *P. polionotus polionotus* and *P. maniculatus bairdii*. It should be noted that in this cross between species there seems to be a certain degree of infertility, for only a few of the attempted matings have been successful.

The species *maniculatus* and *polionotus* are shown by morphological characters to be closely related, and by Osgood[10] both are placed in the same species-group. The ranges of the two species are separated by a wide area in which no form of either species occurs, so that in nature there is no chance for interbreeding.

Attempted crosses in the laboratory between widely differing species have invariably proved to be failures. The species *maniculatus* and *leucopus* both belong to the subgenus *Peromyscus*, and though they are placed in different species-groups, in external appearance they are not very different. Nevertheless, no offspring have been secured from 69 attempted cross matings between *P. leucopus noveboracensis* and 5 different subspecies of *P. maniculatus*. In many of these matings the pair lived together in the same nest for a year or more. All the animals used in the attempted crosses were from stocks known to be fertile, and quite

[7] Adolph Murie, Univ. Michigan, Occas. Pap. Mus. Zool., no. 270, p. 16. 1933.
[8] Lee R. Dice, Journ. Mammalogy, vol. 12, pp. 211–212. 1931.
[9] Sumner, *supra cit.*, pp. 282–283.
[10] W. H. Osgood, U. S. Dept. Agric., N. Amer. Fauna, no. 28, pp. 28, 29, 1909.

a few of the individual mice used in the tests were proved to be fertile with members of their own species. The two species are found together in the same geographical districts in parts of eastern and central North America, often living in the same habitats, and no evidence of interbreeding in nature has been found. The indications are that the two species are never fertile together.

Several attempted crosses between the species *truei* and *maniculatus* also have produced no results. No offspring were secured from 6 matings between *P. truei truei* and several subspecies of *P. maniculatus*. The species *truei* also belongs to the subgenus *Peromyscus*, but it has numerous morphological differences from both *maniculatus* and *leucopus*, and it is placed in a third species-group. Its geographical range in part overlaps that of *maniculatus*, and possibly in some places that of *leucopus*, but it has rather specialized habitat preferences. There is no evidence whatever that in nature it hybridizes with either *maniculatus* or *leucopus*.

The species *eremicus* has proved to be infertile with *maniculatus*, *leucopus*, and *californicus*. Twenty-nine attempted matings between *eremicus* and *maniculatus* have been failures, and so also have been 24 attempted crosses between *eremicus* and *leucopus*. *Eremicus* belongs to a different subgenus, *Haplomylomys*, from *maniculatus* and *leucopus*, both of which are in the subgenus *Peromyscus*. There are many morphological differences between the members of the two subgenera, including important differences in the genitalia, so that crosses involving these subgenera could hardly have been expected to succeed. However, 6 attempted crosses between *eremicus* and *californicus* have also failed. *Californicus* is placed in the same subgenus as *eremicus*, though the two species have many morphological differences. Among other differences *californicus* is more than twice as large as *eremicus*.

No physiological or embryological explanation is available for the failure of most of the attempted species crosses. I have made no effort to determine whether copulation actually occurred. If copulation did occur, the fertilization of the ovum may have been unsuccessful, or perhaps the growth of the embryo was arrested after a longer or shorter period of development. All that can be stated is that the pairs were together for a number of months during the breeding season and that young were not found in the nest.

Fertility relationships in the genus *Peromyscus* seem to be closely correlated with morphological characters. Forms shown by their morphological characters to be closely related prove to be fertile together, and forms somewhat distantly related, as determined from their structural

characters, are less fertile together. For example, all the subspecies of *Peromyscus maniculatus* are relatively fertile together, but seem to be less fertile with the related species *polionotus*. Attempted crosses of more distantly related species have been wholly unsuccessful. The determination of taxonomic relationships in the genus, based on morphology alone, is strikingly supported by these studies of fertility relationships.

The species-group, as this term is employed by mammalogists, is shown by these studies to be of great biological importance. In *Peromyscus* no crosses beyond the species-group have been successful. When these mice have diverged sufficiently in evolution to be classed in different species-groups they apparently have become too different, perhaps through the accumulation of diverse hereditary characters, to be able to hybridize successfully. On the other hand, the members of a species-group, so far as the fertility relationships have been studied in *Peromyscus*, are fertile together, though not equally so.

The diverse stocks of any kind of animal which retain the potentiality of producing fertile offspring when these stocks are mated together, constitute a natural biological unit. This is true even though certain members of the group, for certain intervals of time, may be isolated by barriers of a physical, ecological, or psychological nature. Barriers frequently break down and thus bring the previously isolated stocks again together, more or less completely.

Within the biological unit whose members are able to produce fertile offspring, there is the possibility of interchange of hereditary characters. An hereditary character arising in a single animal may eventually, should the character survive, become part of the heredity of the whole interfertile population. The taxonomic unit which in *Peromyscus* seems to correspond to the biological unit of interfertility is the species-group.

After species have diverged sufficiently to be unable to produce fertile offspring when crossed there is no longer the possibility of interchange of hereditary characters. New characters arising in one population cannot by any biological possibility reach another population with which the first population is infertile. Species or groups of species which are infertile with other groups therefore constitute distinct biological units.

First generation hybrids may sometimes be produced between species which do not produce fertile offspring. A well known example is the infertile mule, which is the hybrid between the horse and the ass. The different kinds of horses, even though differing in important morphological characters, all seem to be fertile together, and they therefore form a

natural biological assemblage. But the horses and the asses differ too much from each other to produce fertile offspring, and they accordingly belong to different biological units. Nevertheless, the horses and the asses have not yet diverged sufficiently to fail to produce offspring when mated together, even though their offspring is infertile. On the contrary, the species-groups of *Peromyscus*, so far as they have been tested, are apparently very divergent physiologically, for when attempts are made to cross these species-groups they fail to produce even first generation hybrids.

SUMMARY

All the geographic races of *Peromyscus* so far tested in the species *maniculatus*, *leucopus*, *truei*, *eremicus*, and *californicus*, produce fertile offspring when mated with other subspecies of their own species.

Crosses between the species *Peromyscus maniculatus* and *P. polionotus* sometimes succeed, and produce fertile offspring. Though their ranges are far separated geographically, the two species are members of the same species-group.

All attempts to cross the species *maniculatus* with *leucopus*, *truei*, or *eremicus* have been failures. Neither could *eremicus* be crossed with *leucopus* nor with *californicus*. The indication is that the mice of different species-groups are infertile together.

All the diverse animals which are potentially interfertile form a natural biological unit, within which interchange of hereditary characters is possible. This biological unit in the genus *Peromyscus* corresponds closely to the taxonomic species-group.

University of Michigan, Ann Arbor, Michigan

HABITS OF THE GROUND SQUIRREL CITELLUS LYRATUS ON ST. LAWRENCE ISLAND, ALASKA

By Otto William Geist

The following observations were made in the course of archeological excavations at the ancient village site of Kukuliak on St. Lawrence Island, conducted for the Alaska Agricultural College and School of Mines, and these excerpts from my field notes appear worthy of placing on record.

On July 9, 1932, during the process of excavating behind a meat cellar at an approximate depth from the surface of three and one half feet, we encountered the nest of a ground squirrel, *Citellus lyratus*, containing five tiny young, evidently just born. The nest consisted of a bunch of dried grass. The mother had also carried in green tips of grasses and weeds gathered near by. This nest was exposed for a short time and I could see the five young crawling about. It was evident that none of the young could see, although they could smell and appeared to identify the grass tips as food and nibbled at them. They seemed quite clumsy but after a minute or so all had worked their way to the interior of this grassy ball. The ball was approximately the size of a man's derby hat.

The mother repeatedly came within a few feet of me and I could observe her closely. She was with the young when the Eskimos uncovered the nest, by removing a rock over it, and she came out at once and ran away. Repeatedly she ran back and forth but would not enter the nest until I had replaced the rock and built up the front of the den, which also was open, with wood and bones. A minute or so later she returned and immediately went through the little opening I left for her and remained with the young for a while. I could hear the young crying, although I cannot describe the peculiar sound. Every now and then the mother would come forth again and would appear not to be disturbed at all by the Eskimo men working with shovels nearby or by my own presence. Later, toward evening, the mother kept running toward the mouth of the excavation, disappearing and returning from time to time, while during the morning she had been running toward the north of the excavation dump. I surmised she was trying to find a new abode for her youngsters. Therefore I set out to watch her for a while.

In a nearby meat cellar which belonged to a house just outside our excavation, she had evidently found an abandoned runway, which she was preparing and cleaning out. She seemed to work very rapidly, but every now and then ventured forth to visit her young again. Evi-

dently there was no suitable material available for the new nest, for she scouted around for a time and finally proceeded toward the many cases, or wooden boxes, which were filled to the top with human skeletal material taken from the recent house in our excavation. The squirrel took advantage of the situation in the following manner: she would jump up to examine the boxes and contents, finding such articles as feathers and trimmings from the much decayed parkas, with which the bodies originally had been covered in the house, and of which particles were still clinging to the bones. The wind had been blowing and the material was fairly dry. The squirrel plucked this material and carried it in her mouth to the newly found den. Repeatedly she returned for the same purpose and finally I noticed her pulling at the hair which still covered some of the human skulls. She succeeded in carrying away during several trips a considerable amount of these human hairs, all of which evidently went towards "feathering the nest" for her young. During the night the mother carried all of her young to the new nest. On July 14 I found her with her five young, all sunning themselves in front of their den in the morning sun. The young seemed to grow very rapidly, and I watched them many times running around our excavation or near their home until the middle of September.

Some of the adult ground squirrels were seen eating the old partly dried, and partly frozen lumps of whale and walrus meat which we excavated at an approximate depth of eight feet under the surface. These pieces of old meat we had stacked in piles and it seemed that the squirrels relished very much the long strands which they were able to pull off, especially from the old whale meat. Some portions of this meat, of course, were rather badly decayed, while some other portions consisted almost entirely of decomposed and dried-up whale blubber and whale skin. They did not seem to carry any of this material away, but I actually watched the animals eat and swallow the pieces that they were able to pull off. Such old meat is very tough and can only be pulled off in long strands.

On August 25, 1932, the teacher's boy came to Kukuliak to shoot mice with bird shot and while he was carrying his game by the tails, one mouse slipped through his fingers and he lost it. He was hunting for the mouse for a considerable time but finally gave up. Shortly afterwards I observed a ground squirrel sitting on its hind legs, holding in its front paws a mouse, from which blood was trickling. The squirrel was in the act of eating the head of the mouse and I could hear very plainly the cracking of the bones, all of which the squirrel evidently swallowed, for

I could find no traces of these bones upon carefully examining the place where the squirrel sat. I watched this squirrel for a considerable time with my graphlex in my hand. The squirrel was eating ravenously on the mouse and ate practically half of it, when finally I was getting ready to take the photo. The natives had been watching me from a distance and, of course, walked right up towards me, not being able to imagine what I was doing. Immediately the squirrel ran away and dropped the mouse. I carried the camera back to the tent, and gave it up as a bad job. In the meantime the squirrel had returned to the remains of the mouse and began to eat again. Every now and then it would lick its paws free of the blood, which was oozing from the little carcass. This time I was less than six feet from the animal, but could not move lest it run away. When I did move it ran through a knot hole into a hollow piece of drift wood, and I thought I would be able to obtain a picture then. The squirrel, however, outwitted me, for while I was focusing my camera on the knot hole, through which the animal tried to escape from time to time, it finally ran out through an opening in the end of the log and off in in an opposite direction.

Upon examining the place where the squirrel had been eating the mouse I found that a few neck vertebrae had been discarded; otherwise all of the mouse with the exception of the hind portion, consisting of the hind legs and tail together with a few vertebrae and the skin, had been consumed. No traces of the skin of the mouse, other than that remaining on the left-over portion, could be found. The intestines of the mouse I found taken out completely, but a small portion was missing, otherwise they were not consumed by the squirrel. The stomach was taken out, bitten open, and cast away. A few bones from the front feet were found. All of these bones were left very clean, not a particle of flesh remaining on them. When the squirrel returned to the carcass it smelled the mouse but did not pick it up again.

Alaska Agricultural College and School of Mines, College, Alaska.

WOOD RATS AND GROUND SQUIRRELS IN ACTIVITY WHEELS

By Harold S. Colton

The activity of wild animals is difficult to record and so any observations that are made are always of value. In the spring of 1927, four of the activity wheels in the laboratory at Flagstaff, Arizona were allotted to wood rats (*Neotoma mexicana pinetorum*). The records ran from May to October. In the autumn, three wheels were reserved for a Say's ground squirrel (*Callospermophilus lateralis arizonensis*, and a rock squirrel (*Otospermophilus grammurus grammurus*) and one wood rat, and winter observations were recorded for those three animals.

The activity wheels in the laboratory at Flagstaff were modified from the type used at the Wistar Institute in Philadelphia (Greenman and Duhring 1923, p. 24) which are built about a ball-bearing bicycle wheel fastened to a vertical background. In the apparatus at Flagstaff, four wheels are attached to one side of an iron frame covered with cellar window wire. On the opposite side of the frame, small cages were attached, 8 inches by 10 inches, in which the animal had its nest and to which the food cup and a water bottle with copper drinking tube were fastened. Counters manufactured by the Veeder Manufacturing Co. of Hartford, Connecticut, and known as Rotary Ratchet Counter No. 6, recorded the number of revolutions of the wheel. The counters were worked by a cam on the axle of the wheel so that beyond a faint tick the wheels were nearly silent. This is an advantage, as the Wistar Institute uses a pendulum to operate the counter, which is quite noisy (see *loc. cit.*, fig. 4). As there is no wood in the construction of the wheel, supporting frame and cage, the apparatus is easily cleaned.

During the spring and summer, seven wood rats were studied in the wheels. They lived very well and most of the records ended when the rat managed to escape while the cages were being cleaned. The longest record covered one hundred and fifty-five days, and ended when the rat was released. The shortest record was for three days, when the rat died. The rats averaged from 5.3 miles to 11.4 miles per night, for the animals sleep in the day time. The maximum distance recorded by one rat in a night was 33.7 miles. Two other rats had single night record maxima of over twenty miles (a thousand revolutions of the wheel equalled 1.1 miles).

These records do not give a complete picture of the activity of the rats. In the wheel most of the rats learned to sit on the axle and rotate the wheel

with one hind leg. Therefore, the revolutions that the counter recorded do not indicate, necessarily, that the rat was running on four feet.

If the counters do not give a true picture of the kind of activity, they do measure the general activity of the animal. To rotate the wheel at least one hind leg is active. Although in the wild state it is improbable that rats ever wander twenty miles or more in a single night, yet we have reason to believe that potentially they can cover a wide area.

In activity wheels female albino brown rats (*Rattus norvegicus*) show a periodic activity corresponding to the periods of heat. An inspection of the daily records of wood rats show no such periodicity in their activity. The activity of female wood rats seems no different than the male. The number of revolutions increase over a long period and then decrease. There is no regularity shown in the records. It is believed that *Neotoma* has but one period of heat a year, in the spring, as they seem to have but one litter a year (Donat, 1933).

TABLE 1

Wood rats in activity wheels

Individual no. of rat	26	25	19	29	28	30	31	32
Sex	♂	♂	♀	♀	♀	♀ yng.	?	♀ yng.
Days in wheel	155	135	45	23	75	26	89	3
Date of starting	May 9	May 9	May 9	July 8	July 21	Sept. 7	Oct. 30	Sept. 22
Date of end	Oct. 14	Sept. 9	July 16	July 31	Oct. 4	Oct. 3	Jan. 27	Sept. 25
Average miles per day	5.2	7.2	11.4	5.3	9.1	6.6	6.7	2.6
Maximum miles in a day	17.5	20.00	16.0	13.6	16.6	21.7	33.7	
Total miles	968	1060	517	127	683	172	601	2.6
Fate	Released	Escaped	Escaped	Died	Escaped	Died	Died	Died

The data for the annual cycle are not very complete. Seven wood rats were in the wheels during the period from May 9 to October 4, and one from October 30 to January 27. The general impression one gains from this mosaic is that the activity increases gradually from spring to the autumn and then falls off in the winter to nearly zero. More data are necessary to fill the gaps.

To supplement the wood rat records, two other small mammals were studied in the wheel, a ground squirrel (*Callospermophilus lateralis arizonensis*) and a rock squirrel (*Otospermophilus grammurus grammurus*). These two animals were kept in the wheels over a winter. The ground squirrel hibernated but the rock squirrel did not. One wood rat was kept in a wheel during the winter. This animal did not hibernate.

The female ground squirrel (*Callospermophilus lateralis arizonensis*) was kept in a wheel from October 8, 1927, to July 31, 1928, 296 days.

This animal reached its maximum in the middle of October. She hibernated October 30, appearing at intervals during the winter as follows: November 19, 25, 26; December 3, 7, and 17. She was out several times in January but no record was kept. She did not appear in February. On March 3, 14, 26, and April 2 she appeared and on April 8 she came out to stay. By the middle of May she was running twelve miles a day. This rate fell away to about one mile a day by the end of July when she broke her leg and had to be killed.

The rock squirrel (*Otospermophilus grammurus grammurus*) was captured on September 8 and kept in the wheel until March 25. Its greatest activity was in the last two weeks of October when it averaged, over a period of fifteen days, 9.2 miles a day. By the end of November the squirrel became retarded in activity but did not hibernate. In the first week in January it averaged but twelve revolutions a day. In the middle of February the number of revolutions a day started to increase. The squirrel then died.

The room in which the animals were kept in the winter was in a barn, unlined and unheated. However, there was a lined and heated room next to it, so the temperature was a few degrees higher than that outside. The Flagstaff winter is severe, although the winter of 1927 to 1928 was not extreme. The minimum outdoor temperature for November, 1927, was 14°; December, –6°; January, 1928, –7°; February, 0°; March, 14°. The maximum outdoor temperature for December, 1927, was 45°; January, 1928, 60°; February, 53°; March, 65° (Fahrenheit).

On zero nights the temperature of the heated room dropped to freezing so it did not greatly affect the unheated room next door.. The nests were probably colder than the natural nests of the rodents, which are pretty snug places. The wood rat No. 31 probably froze to death.

It is impossible to draw definite conclusions from the above experiments. The great activity of the animals is the most striking feature. The complete daily records are on file in the Museum of Northern Arizona, and are available to interested zoologists.

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University of Pennsylvania.

A REVISION OF THE GENUS PTEROPUS FOUND IN THE ISLANDS OF THE RIU KIU CHAIN, JAPAN

By Nagamichi Kuroda

From the islands of the Riu Kiu Chain the following species of the genus *Pteropus* have been described:

1. *Pteropus yamagatai* Kishida. Kuchino-Erabujima, near Yakushima.
2. *Pteropus daitoensis* Kuroda. Borodino Islands.
3. *Pteropus loochoensis* Gray. Okinawa, Middle Riu Kiu Islands.
4. *Pteropus dasymallus* Temminck. Yayeyama group, South Riu Kiu Islands.

The third species is obviously different from the others and is a subspecies of *Pteropus mariannus*. The other three forms, however, have given rise to a good deal of discussion.

Pteropus yamagatai was discovered by Mr. R. Yamagata on a small island, Kuchino-Erabu of the North Riu Kiu Chain in 1929; it was described as a new species by Mr. Kishida in the same year. Kishida[1] stated that *P. yamagatai* might be identical with *P. dasymallus* of Temminck. Temminck described the latter from Nagasaki and "Jeddo" = Tokyo (ex Siebold's *rubricollis*, not of Geoffroy) and some years later several other authors gave South Kiusiu and Yakushima as localities for *P. dasymallus*. But more recently Owston's Japanese collectors and the zoological exploration by Kuroda's collector, Mr. H. Orii, in the Riu Kiu Chain failed to secure a specimen of *Pteropus* on the island of Yakushima. Mr. R. Yamagata, however, has been fortunate enough to discover six specimens (4 males and 2 females) of a species, *P. "yamagatai,"* on the small island Kuchino-Erabu, instead of Yakushima proper. The former island is situated 12 kilometers from the north-west point of Yakushima. It remains to be determined whether *P. dasymallus* of Temminck was brought from Kuchino-Erabu or from the Yayeyama group in the South Riu Kiu Islands, where a series of specimens was collected by Owston's Japanese collectors in 1899 (one specimen obtained; see Bangs, Amer. Nat., vol. 35, 1901, p. 561) and 1904; those taken during the latter year are preserved in the British Museum. These specimens have been identified as *P. dasymallus* by K. Andersen,[2] who has given the following historical account of the species:

[1] "Lansania," Tokyo, vol. 1, no. 9, pp. 135–142. December 13, 1929 (In Japanese).

[2] Catalogue of the Chiroptera in the collection of the British Museum, ed. 2, vol. 1, Megachiroptera, 1912, p. 162.

"In recent times the species [*dasymallus*] has only been obtained in the S. Liu-kiu Islands. . . . . There can be little doubt, therefore, that Siebold was mistaken as to the habitat of *dasymallus*; very likely he saw and obtained this species in Kiushiu and Hondo; it is frequently brought alive to Japan from the Liu-kiu Islands and kept in captivity by the Japanese." Mr. Kishida also agrees with Andersen's view; but he thought that the Kuchino-Erabu specimens were possibly brought to Kiusiu or Hondo in the olden times, and that the form then recognized as *P. dasymallus* includes *P. yamagatai*. Dr. Andersen (*loc. cit.*) examined the type specimen of *P. dasymallus* and commented as follows: "The type in the Leyden Museum is an immature (not quite full-grown) mounted individual, skull extracted. The surface of the fur, above and beneath, has faded to whitish or creamy whitish; base of hair less bleached. Skull and teeth as in British Museum specimens from the Liu-kiu Islands."

I obtained a pair of *Pteropus yamagatai* from Mr. Kishida by exchange and have compared them with a large series of *P. dasymallus* from the islands of Ishigaki (13 specimens), Iriomote (6 specimens), and Yonakuni (9 specimens) in the Yayeyama group. As a result of this comparison, it becomes clear that *P. yamagatai* Kishida is a synonym of *Pteropus dasymallus dasymallus* Temminck.

For the above reason I regret that I can not sustain the opinion of Messrs. Andersen and Kishida, who considered the true habitat of *Pteropus dasymallus* to be the Yayeyama group, South Riu Kiu Islands. I, therefore, designate the restricted type locality of *P. dasymallus* as Kuchino-Erabu near Yakushima in the North Riu Kiu Chain. It then follows that the synonymy of this fruit bat should stand as:

Pteropus dasymallus dasymallus Temminck

Japanese: Erabu-ohkohmori

1824. *Pteropus rubricollis* Siebold, De Hist. Nat. in Japonia statu, p. 13. ("Nagasaki" and "Jeddo") (*nec* Geoffroy, 1810).

1825. *Pteropus dasymallus* Temminck, Mon. Mamm., vol. 1, p. 180, pls. 10 and 15. (Supposed to have come from "Nagasaki and Jeddo," but actually restricted to Kuchino-Erabu, North Riu Kiu Chain.)

1929. *Pteropus yamagatai* Kishida, "Lansania," Tokyo, vol. 1, no. 8, p. 125. November 27, 1929. (Kuchi-no-Erabu in Kagoshima-ken, Kiushiu.) Type in Kishida collection.

Characters.—Male: Muzzle and chin nearly black instead of dark brown as in the Yayeyama form; collar on throat well defined without a longitudinal stripe dividing it as in the latter form; sides of back very conspicuously dark brownish black instead of dark brown as in the latter. Female: Muzzle and face nearly black instead of paler dark brown as in the female of the Yayeyama form; front of

head blacker and occiput umber brown instead of yellowish brown as in the latter; collar on mantle cream buff instead of creamy white; almost without a longitudinal pale stripe on breast and abdomen instead of frequently with a stripe as in the latter. The female closely resembles that of the Yayeyama form.

Skull.—Not differing appreciably from that of the Yayeyama form, but total length in males slightly greater.

Habitat.—Kuchino-Erabu, N. Riu Kiu Chain.

Remarks.—Mr. K. Nagai discovered a female in winter pelage on a small island named Takarajima in the Northern Riu Kiu Chain; the date is not published. According to Mr. Kishida,[2] this unique specimen has been examined by him and compared with his *Pteropus "yamagatai."* He found that it resembles the latter very much, but it should be distinguished as a local race. Kishida, however, has not given a subspecific name to it, hoping that an adult male of this form would be obtained. The Takarajima specimen is said to be preserved in the Local Museum attached to the Kagoshima Library.

Pteropus dasymallus daitoensis Kuroda

Japanese: Daitojima-ohkohmori

1921. *Pteropus daitoensis* Kuroda, Journ. Mamm., vol. 2, no. 4, p. 210. November, 1921. ("Kita-Daitojima," probably in error for Minami-Daitojima, Borodino Islands.)

Characters.—This is a very remarkable animal. Coloration of crown, occiput, hind neck, mantle, breast, and center of abdomen whitish buff, slightly washed with yellowish; a large bright golden buff patch on each side of neck and continued in the middle of fore neck. In the female, the yellowish wash is paler and the golden buff patch is also paler.

Skull.—Entirely similar to that of the Yayeyama form.

Habitat.—Confined to Minami-Daitojima in the Borodino Islands, 392.4 kilometers southeast of Naha, Okinawa Island.

Remarks.—In 1921, I described it as a species, but I am now inclined to think that it has an intermediate relationship, except for coloration of fur, between the northern form, *P. dasymallus*, and the southern Yayeyama form.

Pteropus dasymallus inopinatus, new subspecies

Japanese: Orii-ohkohmori

Type.—Male adult; February, 1922; collector, H. Orii; N. Kuroda coll. no. 550.

Type locality.—Nago-mura, Kunjan, Okinawa Island, Central Riu Kiu Islands.

Habitat.—Confined to the Okinawa Island, Central Riu Kiu Islands.

Characters.—Muzzle and face dark brown as in the Yayeyama form, but not blackish, and paler than *dasymallus* of Kuchino-Erabu, North Riu Kiu Chain; frontal neck collar dusky whitish buff, separated by a broad longitudinal band; lower border of the frontal neck collar rather well defined; crown of head vandyke brown; occiput russet; sides of neck with a large dark rufous-buff patch; hind neck collar and mantle very dark brownish buff, slightly paler in the former and

[2] "Lansania," vol. 2, no. 11, pp. 6–10. February 11, 1930. (In Japanese.)

scarcely forming a collar on hind neck; back brown, the border between mantle and back very obscure; rump more or less paler and more buffy than back; sides of back and entire underparts from lower neck downwards uniform blackish vandyke brown, slightly sprinkled with rufous buff hairs on center of breast; sides of body and flanks more black than breast. The ground color of the entire underparts, except the neck collar, is very dark in tone, while the upper parts are more buffy and browner (except the head and hind neck) than any of the known forms of the Japanese fruit bats.

Skull.—Not differing from that of the Yayeyama form; slightly shorter than the greatest length of *P. dasymallus* from Kuchino-Erabu.

Measurements in millimeters

NO.	SEX	FOREARM	SKULL, GREATEST LENGTH	SKULL, BASILAR LENGTH	SKULL, ZYGOMATIC BREADTH	SKULL, BREADTH OF BRAIN CASE	UPPER TOOTH ROW INCLUDING CANINE
550 (type)	♂ ad.	130	61		34	23	23.5
1129	♂ subad.	126.5	60	54	31.5	22.5	23

Remarks.—On Okinawa Island, we have another species, *P. mariannus loochoensis*. The *dasymallus* group has not before been recorded to the best of my knowledge. The former form has a longer forearm, varying from 135 to 142.5 mm. (*cf.* Andersen, *l. c.*, p. 182), the furred area on the back is narrower and the fur of back is directed posteriorly instead of being long and spreading as in the *dasymallus* group. It is a very remarkable fact that the two different species of fruit bats are found on Okinawa Island.

Pteropus dasymallus yayeyamae, new subspecies

Japanese: Yayeyama-ohkohmori

1901. *Pteropus dasymallus* Bangs, American Naturalist, vol. 35, p. 561. (Ishigaki) (*nec* Temminck)

1912. *Pteropus dasymallus* K. Andersen, Cat. Chiroptera Brit. Mus., ed. 2, vol. 1, Megachiroptera, p. 159. (South Liu-kiu Islands) (*nec* Temminck)

Type locality.—Ishigaki.

Habitat.—Confined to the Yayeyama group, South Riu Kiu Islands. Specimens obtained from Ishigaki (restricted type locality), Iriomote, Kobama, and Yonakuni.

Characters.—Very similar to *P. dasymallus* Temminck from Kuchino-Erabu, North Riu Kiu Chain, in having muzzle and chin dark brown, not blackish; collar on throat well defined, but with a more or less longitudinal band; sides of back dark brown, not blackish. In the female the difference between this form and *P. dasymallus* has been already noted in describing the characters of the latter. Two allied forms, *P. daitoensis* and *P. inopinatus*, are manifestly distinct from *P. yayeyamae*.

Skull.—In males: Total length under 63.5 mm. instead of 64–65.7 mm. as in four males of "*yamagatai*" (=*dasymallus*).

Remarks.—The reason for giving a new name to this form has been given at the beginning of this revision.

On the Yonakuni Island, nearly all the females (adults and juveniles) are melanistic in coloration without a paler collar on neck. In a few specimens, the dark hue is replaced by buff or yellowish. One old male is golden buff, quite as in the males from Ishigaki and Iriomote now before me. I have a melanistic old male (no. 545), without neck collar, from Ishigaki which seems to be a very rare condition among males.

Note.—The Formosan form, *P. formosus* Sclater, was figured on plate 22 of the Proc. Zool. Soc. London, 1873, without description. The type specimen of it was said to have come from Takoo (= Takao in Japanese) in S.W. Formosa. But according to our present knowledge, this fruit bat is known to occur on a small island Kashoto, east of Formosa. Mr. Horikawa (Monogr. Formosan Mamm., 1932, p. 55) has recorded an accidental straggler(?) obtained at Kareien near Karenko, east coast of Formosa. My male specimen was also collected on the Island of Kashoto (I designate this island as the type locality of *formosus*). Inasmuch as Sclater and Andersen consider this animal to resemble *Pteropus dasymallus*, only differing in the longer fur and darker color, I do not hesitate to rank it as a subspecies of *dasymallus*.

Fukuyoshi Cho, Akasaka, Tokyo, Japan.

THE LEAST WEASEL A CIRCUMBOREAL SPECIES

By Glover M. Allen

The least weasel, smallest of the known Carnivora, was first clearly distinguished by the late Outram Bangs, who, in his review of the weasels of eastern North America (Proc. Biol. Soc. Washington, vol. 10, p. 21, 1896), named it *Putorius rixosus*, designating as the type a female from Osler, Saskatchewan. Baird had previously suspected its distinctness from the small eastern species with a black tail-tip, *Mustela cicognanii*, but failed to characterize it. In the Journal of Mammalogy, vol. 7, p. 313, ff, 1926, Dr. M. H. Swenk has summarized our knowledge of this species in North America up to that date and indicated the distribution of the four North American races: *M. rixosa eskimo* (Stone) in northern and western Alaska from Point Barrow to Norton Sound and Kuskokwim Bay; *M. r. rixosa* (Bangs) from north-central Alaska to Hudson Bay (more recently to southern Labrador) and Minnesota; *M. r. campestris* Jackson of the prairie region of Nebraska; and *M. r. allegheniensis* (Rhoads) from Wisconsin, across Pennsylvania and Ohio to North Carolina. It is noteworthy that in spite of the large amount of intensive collecting done in New England, no record of it has yet been made from New York to Nova Scotia, although its occurrence is to be looked for.

In essential characters these four races are closely similar. All agree in their diminutive size and extremely short tail which only slightly exceeds the length of the hind foot, and in skins, as usually made up, does not extend beyond that member. In winter the entire pelage is white from muzzle to tail tip, but in summer the dorsal surface of head, body, and limbs, and both surfaces of the tail are brown; the fore feet, more or less of the toes of the hind feet, and the belly are white. There is no rictal dark spot in any of the dozen or more skins I have examined, so that its absence may be regarded as a usual character. The race *eskimo* may generally be distinguished by the fact that the white of the throat extends dorsally as a somewhat triangular re-entrant from the upper lip to just behind the eye, whereas in the other races the boundary of the brown color is straight across the cheeks from the corner of the upper lip to well below the eye and ear.

In 1903, the late Dr. J. A. Allen announced the discovery of a weasel of this group in Siberia and described it as *Putorius* (*Arctogale*) *pygmaeus* taking as the type a male from Gichiga, west coast of the Okhotsk Sea. One of its chief distinctions lies in the very short tail, a little less than the hind foot in length, instead of (usually) a little more, up to nearly twice the length of the foot for the American species, although the table of measurements published by Swenk shows a certain amount of variation within narrow limits. Allen mentioned additional specimens from Marcova and farther north, from Verkhene Kolimsk in Siberia. Kuroda (Journ. Mammalogy, vol. 2, p. 209, 1921) formally made *pygmaea* a subspecies of *M. rixosa* and at the same time described as new a Japanese race, *M. rixosa namiyei*, from northern Hondo, with a slightly longer tail (26–30 mm.). More recently, in 1929 (Amer. Mus. Novitates, no. 358, p. 5), I recorded three additional specimens of *M. rixosa pygmaea* secured by Dr. R. C. Andrews's Asiatic Expeditions near Urga in northern Mongolia, thus extending the known range well to the westward. I have now to place on record two other specimens, from Verknoyansk and Novenskoye, respectively, in northern Siberia; as well as a third perfectly typical example in summer coat from Parvik, Finmark, northern Norway. These three were all sent me as *Mustela nivalis* but are readily told from that species, which also ranges from eastern Asia to western Europe, by (1) the smaller size; (2) shorter tail (not extending beyond the outstretched hind foot); (3) the white fore feet and white hind toes; and (4) by the lack of a dark rictal spot behind the corner of the mouth. Apparently the presence of this rictal spot is of itself usually quite sufficient to distinguish the small females of *M. nivalis* and its races. It is wanting in all the examples of *M. rixosa* and its subspecies that I

have seen. It thus becomes evident that *Mustela rixosa pygmaea* extends quite across the northern part of Eurasia from Siberia to Norway and that as a species *Mustela rixosa* is circumboreal.

In examining the weasels in the Museum of Comparative Zoology previously referred to *Mustela nivalis*, I discovered among them a single made-over skin with skull sent many years ago to Louis Agassiz from Switzerland, that is undoubtedly of the *rixosa* group. Its color in summer pelage is a slightly paler brown than that of *M. r. pygmaea*, the entire upper lip is edged with white, the line of demarcation along the cheeks is fairly high, reaching the base of the ear, there is no dark rictal spot, the hind toes are white, and the tail does not exceed in length the extended hind foot. It is strange that European zoologists should for so long have failed to distinguish between this species and *M. nivalis*. Of the latter, much has been written concerning its wide variation in size, hence it seems likely that both species have often been confused under this name, probably because of the close approximation in dimensions between the adult males of the *rixosa* type and the females of *M. nivalis*. The only author to recognize the fact that a small type of weasel was included with the larger one, seems to be Cavazza, who in a series of studies on large numbers of weasels, finally concluded that in the highlands of central Europe (Switzerland and northern Italy) occurred a smaller and rarer type with a smaller skull, to which he gave the name *Putorius nivalis monticola*. Although he did not clearly distinguish this from the larger species, there can be no doubt that his name applies to the race of least weasel occurring in the Alps and neighboring parts of central Europe.

While this article was going through the press, I have had the privilege of examining the series of Old World weasels in the British Museum (Natural History) referred to *M. nivalis*, and have found among these a dozen examples of the *rixosa* group. A brief examination indicates the following as *M. rixosa pygmaea:* three from Novenskoye, Siberia; one from Alzamai, Yenesei; three from Djarkent, Semiretchensk; an old specimen from Brandt labelled merely "Siberia"; one from Surendal, and one from near Christiania, Norway. The only specimen from the region of central Europe was from Oberengadin, Switzerland, the close agreement of which with typical *pygmaea* rather casts doubt on the validity of an Alpine race. Finally, it appears that Barrett-Hamilton's type specimen of *Putorius nivalis caucasicus* is a closely allied race, differing chiefly in the slightly longer tail and in having the line of demarcation between the dark dorsal surface and the white under side of

the head rather lower, for whereas in *pygmaea* it cuts just below the eye, sometimes with the border indented by the white behind or below the eye, passing then to the base of the ear, in *caucasica* the brown area extends lower so as to include the eye and the ear well within it. In addition to the type, there is a second specimen from Tozcat, Turkey in Asia.

The Old-World races of the species, so far as at present ascertained, are then as follows:

Mustela rixosa pygmaea (J. A. Allen)

Putorius (Arctogale) pygmaeus J. A. Allen, Bull. Amer. Mus. Nat. Hist., vol. 19, p. 176, 1903: Gichiga, Siberia.

Mustela rixosa pygmaea Kuroda, Journ. Mamm., vol. 2, p. 209. 1921.

Range.—Eastern Siberia to Norway.

Mustela rixosa namiyei Kuroda

Mustela rixosa namiyei Kuroda, Journ. Mamm., vol. 2, p. 209, 1921: Awomori, northern Hondo, Japan.

Range.—Hondo, Japan.

Mustela rixosa monticola (Cavazza)

Putorius nivalis monticola Cavazza, Ricerche sui "Putorius nivalis" e sui "Putorius ermineus" d'Italia, Bologna, p. 37, 1908: high valleys of the Alps. Zool. Anzeiger, vol. 34, p. 594, 1909; Boll. Mus. Zool. Anat. Torino, vol. 29, no. 690, 19 pp., 1914; Archiv. de Zool. Exp. et Gén., vol. 54, p. 501, pl. 25, 1915.

Range.—Alpine highlands of Switzerland and northern Italy.

Mustela rixosa caucasica (Barrett-Hamilton)

Putorius nivalis caucasicus Barrett-Hamilton, Ann. Mag. Nat. Hist., ser. 7, vol. 5, p. 48, 1900: Mons Hotschal, Caucasus.

Range.—Caucasus region.

Museum of Comparative Zoology, Harvard College, Cambridge, Mass.

A NEW RACE OF BEAVER FROM BRITISH COLUMBIA

By Seth B. Benson

In the course of field work in east-central British Columbia in the neighborhood of Barkerville, Mr. Thomas T. McCabe and Mrs. Elinor Bolles McCabe have obtained a considerable number of beavers. These animals, presented to the Museum of Vertebrate Zoology by Mr. and Mrs. McCabe, were found to differ so much from specimens taken in the adjacent regions as to indicate the existence of an unnamed race, described below:

Castor canadensis sagittatus, new subspecies

Type.—Female, young adult, complete skeleton and skin; no. 43906, Mus. Vert. Zool.; from Indianpoint Creek, elevation 3200 feet, 16 miles northeast of Barkerville, British Columbia; collected October 2, 1929, by T. T. and E. B. McCabe; original no. 500.

Diagnosis.—A dark colored beaver, with dark grayish ventral underfur. Skull with narrow, pointed rostrum; angle between side of rostrum and zygomatic arch obtuse, so much so as closely to approach a straight line; nasals anteriorly narrow and pointed.

Range.—Known only from the Cariboo Range, in east-central British Columbia.

Specimens examined.—Total number 31, including 2 complete skeletons with skins, 1 skull with skin, and 28 skulls, from the following localities near Barkerville: Ahbau Lake, 1; Beaver Pass, 1; Bowron (Bear) Lake region, 9; near Cottonwood, 2; Cunningham Creek, 7; Fourteen Mile Creek, Bowron River, 5; Indianpoint Creek, about 16 miles northeast of Barkerville, 2; near Indianpoint Lake, 15 miles northeast of Barkerville, 1; Indianpoint Lake, 1; Isaacs Lake, 1; Swift River, 1.

Comparisons.—Color: Much darker than *Castor canadensis subauratus* and *Castor canadensis frondator*. Similar to *Castor canadensis phaeus*, but paler, underfur clearer gray, dorsal overhairs more reddish. Darker than *Castor canadensis belugae*, dorsal overhairs less reddish, underfur darker and less tinged with brown. Similar to *Castor canadensis leucodontus*, but underfur less tinged with brown. Probably closely similar to *Castor canadensis canadensis* and darker than *Castor canadensis pacificus* (skins of these races not examined). Skull: Compared with *belugae*: Rostrum narrower, more pointed; angle formed by side of rostrum and zygomatic arch more obtuse; nasals anteriorly narrower and more pointed; skull more nearly flat dorsally, less concave in front of parietal-supraoccipital suture; occipital crest more inclined posteriorly and projecting farther backward past plane of occiput. Compared with *canadensis*: Differs as from *belugae* except that occipital crest is less inclined posteriorly and does not project as far past plane of occiput. Compared with *pacificus*: Differs as from *belugae* save that *sagittatus* is smaller; has less tendency to retain a flat, triangular area at juncture of sagittal and occipital crests; foramen magnum less symmetrical, tending more often to possess a dorsal embayment. *Sagittatus* is

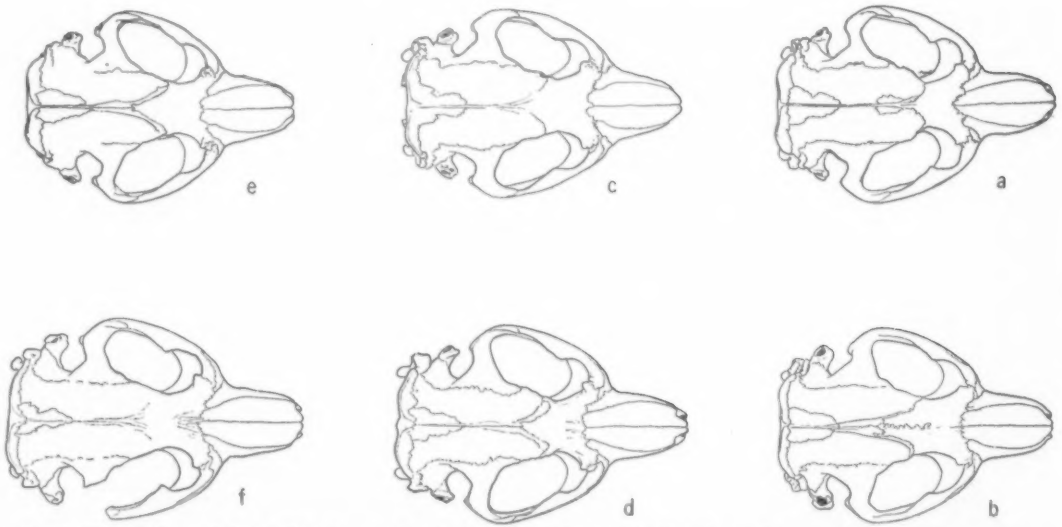

FIG. 1. Dorsal views of skulls of *Castor canadensis*, × ¼. Drawings made directly on photographs and the images subsequently removed. *a. Castor canadensis phaeus*, ♂ adult, no. 210, Mus. Vert. Zool.; Hasselborg Lake, Admiralty Island, Alaska. *b. Castor canadensis belugae*, type, ♂ adult, no. 4224, Mus. Vert. Zool.; Beluga River, Alaska. *c. Castor canadensis sagittatus*, adult, no. 46908, Mus. Vert. Zool.; Bowron Lake, near Barkerville, British Columbia. *d. Castor canadensis canadensis*, adult, no. 106905, U. S. Nat. Mus. (Biological Survey coll.); York Factory, Manitoba. *e. Castor canadensis leucodontus*, ♂ adult, no. 12101, Mus. Vert. Zool.; Alberni, Vancouver Island, British Columbia. *f. Castor canadensis pacificus*, ♂ adult, no. 87629, U. S. Nat. Mus. (Biological Survey coll.); Lake Cushman, Mason County, Washington. These specimens, except for that of *belugae*, are old adults. The specimen of *belugae* is fully adult but slightly younger than the other specimens.

distinct from *phaeus* in its wider interorbital space, from *leucodontus* in its narrower hamular processes, and from *subauratus* in its pointed rostrum.

Description of type specimen.—Color (based on type, with terminology after Ridgway, Color Standards and Color Nomenclature, 1912): Mid-dorsally, overhair cinnamon-brown, underfur bone brown; cheeks, overhair clay color, underfur bister; base of tail at side, overhair sayal brown, underfur hair brown; mid-ventrally, overhair mummy brown, underfur drab-gray.

TABLE I

Cranial measurements in millimeters of adults of four subspecies of Castor canadensis

Specimens all old, having suture between basioccipital and basisphenoid closed, and having short-crowned teeth; arranged from top to bottom in order of increasing age. The specimens of *belugae* and *sagittatus* are in the Museum of Vertebrate Zoology, *canadensis* and *pacificus* in the United States National Museum, Biological Survey collection.

MUS. NO.	SEX		BASILAR LENGTH (OF HENSEL)	ZYGOMATIC WIDTH	MASTOID WIDTH	INTERORBITAL CONSTRICTION	LENGTH OF NASALS	WIDTH OF NASALS	MAXILLARY TOOTHROW	VERTICAL DIAMETER OF FORAMEN MAGNUM	TRANSVERSE DIAMETER OF FORAMEN MAGNUM
Castor c. belugae											
4224	♂	Beluga River, Alaska	116.4	95.2	64.7	25.0	48.1	21.8	30.8	14.6	19.0
4228	♂	Beluga River, Alaska	116.0	—	62.7	24.4	47.1	21.6	30.0	15.2	17.7
4232	?	Kasiliff River, Alaska	112.2	91.2	59.4	23.4	44.0	21.1	29.0	11.5	17.6
4230	♂	Nenilchuk, Alaska	110.9	89.6	57.9	22.9	43.7	22.8	29.2	13.2	16.5
4225	♂	Beluga River, Alaska	122.1	101.2	67.9	24.5	50.2	25.9	31.6	13.5	18.5
Mean			115.5	94.3	62.5	24.0	46.6	22.6	30.1	13.6	17.9
Minimum			110.9	89.6	57.9	22.9	43.7	21.1	29.0	11.5	16.6
Maximum			122.1	101.2	67.9	25.0	50.2	25.9	31.6	15.2	19.0
Castor c. sagittatus											
44666	?	Near Cottonwood, B. C.	119.4	93.9	62.9	24.4	47.8	23.2	29.8	14.4	19.0
44672	?	Fourteen Mile Creek, Bowron River, B. C.	119.3	91.2	65.1	20.0	46.0	23.7	28.3	14.9	19.9
43768	?	Cunningham Creek, B. C.	113.4	93.8	64.5	24.0	44.5	21.8	30.4	13.5	18.3
43775	?	Bowron Lake, B. C.	116.1	94.6	63.0	24.8	49.2	22.5	30.0	14.8	19.3
43771	?	Bowron Lake, B. C.	117.0	91.3	66.5	23.6	49.2	22.8	29.9	13.6	19.3
46908	?	Bowron Lake, B. C.	116.8	91.8	64.4	24.4	47.7	22.7	31.4	15.2	19.8
43766	?	Cunningham Creek, B. C.	112.7	88.5	61.8	23.2	47.1	21.6	28.3	14.9	19.9
44671	?	Fourteen Mile Creek, Bowron River, B. C.	112.6	90.2	65.3	22.5	46.3	21.5	29.1	15.3	20.2
Mean			115.9	91.9	64.2	23.4	47.2	22.5	29.6	14.6	19.3
Minimum			112.6	88.5	62.9	20.0	44.5	21.5	28.3	13.5	18.3
Maximum			119.4	94.6	66.5	24.8	49.2	23.7	31.4	15.3	20.2

TABLE 1—*Concluded*

MUS. NO.	SEX		BASILAR LENGTH (OF HENSEL)	ZYGOMATIC WIDTH	MASTOID WIDTH	INTERORBITAL CONSTRICTION	LENGTH OF NASALS	WIDTH OF NASALS	MAXILLARY TOOTHROW	VERTICAL DIAMETER OF FORAMEN MAGNUM	TRANSVERSE DIAMETER OF FORAMEN MAGNUM
		Castor c. canadensis									
110170	?	Oxford House, Keewatin	115.0	89.6	61.5	25.7	50.3	21.7	27.5	13.1	19.7
246543	♀	Algonquin Park, Ontario (transplanted to Conrad, Penn.)	119.2	93.8	65.1	26.4	44.8	24.3	31.0	13.9	18.7
115980	♀	Cross Lake, Keewatin	123.2	94.4	—	22.6	51.3	26.5	32.1	13.4	20.9
110152	♀	Oxford House, Keewatin	115.9	92.6	—	24.9	46.7	24.5	29.1	13.6	18.2
246536	?	Algonquin Park, Ontario (transplanted to Union Co., Penn.)	118.6	97.0	63.5	25.1	47.8	22.7	31.2	16.2	19.4
110173	♀	Oxford House, Keewatin	117.0	94.1	65.3	24.7	49.7	24.4	28.3	13.2	19.3
106905	?	York Factory, Keewatin	122.5	98.2	68.7	24.4	51.7	24.2	30.0	13.1	20.2
		Mean	118.8	94.2	64.8	24.8	48.9	24.0	29.9	13.8	19.5
		Minimum	115.0	89.6	61.5	22.6	44.8	21.7	27.5	13.1	18.7
		Maximum	123.2	98.2	68.7	26.4	51.7	26.5	32.1	16.2	20.9
		Castor c. pacificus									
235454	♀	Loomis, Washington	117.4	97.1	66.8	26.7	48.5	22.6	34.2	15.7	19.5
78396	♂	Lake Cushman, Washington	116.5	92.3	65.2	23.6	50.6	22.9	30.2	14.6	19.2
87495	♂	Hamilton, Washington	120.0	98.2	66.0	23.0	49.8	23.1	30.5	15.2	21.3
71276	♀	Lake Cushman, Washington	124.0	95.2	68.2	26.9	48.8	23.9	30.7	11.0	18.2
87629	♂	Lake Cushman, Washington	124.7	98.4	68.2	25.4	52.2	24.5	33.4	14.7	19.0
		Mean	120.5	96.2	66.9	25.1	50.0	23.4	31.8	14.2	19.4
		Minimum	116.5	92.3	65.2	23.0	48.5	22.6	30.2	11.0	18.2
		Maximum	124.7	98.4	68.2	26.9	52.2	24.5	34.2	15.7	21.3

Remarks.—In attempting to determine the subspecific status of the beaver of the Barkerville district, the material examined included, besides the material obtained since the time of Taylor's study, most of that used by him in his work on western beavers (W. P. Taylor, Univ. Calif. Publ. Zool., vol. 12, 1916, pp. 413–495, figs. A-Q). The results of my review of all this material agree in general with those of Taylor. However, the additional material shows the existence of another race, allows a more satisfactory definition of the ranges of some of the other races, and shows that some of the characters previously supposed sharply to distinguish certain of the subspecies are inconstant.

Castor canadensis phaeus Heller appears to be restricted to Admiralty Island. Specimens of beavers from near the mouth of the Stikine River on the mainland of Alaska and British Columbia south of Admiralty Island do not have the small size, dark color, and narrow interorbital space which characterize *phaeus*, but, as set forth below, are referable instead to *belugae*.

Castor canadensis leucodontus Gray is restricted to Vancouver Island. While closely resembling *Castor canadensis pacificus* Rhoads, it is distinct, as Taylor has pointed out, in its broader hamular blades of the pterygoids and in the different shape of the nasals. Beavers from the west branch of the Homalko River, on the mainland opposite Vancouver Island, are referable to *belugae*.

It is thus necessary to consider the relationships of *sagittatus* only with *belugae*, *canadensis*, and *pacificus*, as these are the races whose ranges meet that of *sagittatus*.

Castor canadensis belugae Taylor differs from *sagittatus* as noted above. Its range extends from the Cook Inlet region of Alaska south along the coast to southern British Columbia. Specimens from the lower Stikine River, while differing from typical *belugae*, show no approach toward *phaeus*, but grade instead toward *sagittatus*. In southern British Columbia, specimens from Anahim Lake, near the head of the Dean River, also approach *sagittatus* in the shape of the rostrum. Specimens from the west branch of the Homalko River, opposite Vancouver Island, do not have the broad hamular blades that characterize *leucodontus*. While not typical of *belugae* they are referred to that race because they retain the curved outline of the nasals, and the upright occipital crest which distinguish *belugae* from *pacificus*. In these specimens, in contrast with those from Anahim Lake, the sides of the rostrum are more nearly parallel, thus being more like *belugae* and *pacificus* than like *sagittatus*. Taylor assigned to *belugae* specimens from near Stuart Lake in British Columbia. These the present writer has not seen, but if they are referable to *belugae* rather than to *sagittatus*, the ranges of the two races must meet in the northern portion of the Fraser River drainage system.

The range of *Castor canadensis canadensis* Kuhl probably meets that of *sagittatus* in the Rocky Mountains. The latter race shows an approach toward *canadensis* in the flatness of its skull and in the backward-projecting occipital crest.

Castor canadensis pacificus Rhoads of the Columbia River drainage system probably intergrades with *sagittatus* in south-central British Columbia, although specimens showing actual intergradation have not been examined.

Among the described races of beaver in western North America differences in color and size between geographically adjacent races are slight, although races far distant from one another may differ greatly with respect to these characters. Thus the southernmost races (*mexicanus* and *frondator*) are conspicuously larger and paler than the northernmost (*phaeus* and *belugae*). Between *sagittatus* and its neighbors, differences in size and color are slight. The most easily recognized differences between these races are ones of proportion in the skulls, and, for the most part, these are of such character as to be difficult to express by means of measurements.

The table of measurements of the skulls shows the close correspondence in size between comparable specimens of *sagittatus* and its nearest geographic neighbors. These measurements are to be compared with those given by Taylor (*op. cit.*). It is to be noted that the measurements obtained by the present writer do not all agree with those obtained by Taylor from the same skulls. Also, different results were obtained in estimating the age of the skulls. Taylor used the degree of fusion of the temporal ridges to form a sagittal crest as the criterion of age. Better criteria for judging age in the older beavers seem to be provided by the

degree of closure of the suture between the basioccipital and basisphenoid bones, the length of the molariform teeth from root to crown, and, in connection with these features, the degree of formation of the sagittal crest. As beavers increase in age, the mentioned suture gradually becomes obliterated. The molariform teeth of beavers are open-rooted until about the second year. At this time the teeth are at a maximum in length from root to crown. Subsequently the teeth become rooted and cease to grow. As they are worn down by use, the amount of wear is compensated for by the formation of bone beneath the roots. By this means the teeth are pushed toward the grinding surface. Thus the length of the teeth indicates the length of time they have been in use. There are specimens in Museum of Vertebrate Zoology, exemplified by no. 31273, in which the molariform teeth are worn down to the roots. These show but little trace of the enamel folds.

Material used for comparison (the collection of beaver in the Museum of Vertebrate Zoology and certain specimens in the United States National Museum loaned by the Bureau of Biological Survey): Specimens of *belugae*: 16 from Alaska (including the type), 29 from the region of the lower Stikine River in British Columbia, 5 from Anahim Lake, 3 from west branch of Homalko River. Specimens of *canadensis* (U. S. Nat. Mus., Biol. Surv. coll.): 5 from vicinity of Hudson Bay in Keewatin and Manitoba, 2 from Ontario. Specimens of *frondator*: 7 from lower Colorado River, California. Specimens of *leucodontus*: 11 from Vancouver Island. Specimens of *pacificus* (U. S. Nat. Mus., Biol. Surv. coll.): 6 from Washington. Specimens of *phaeus*: 6 from Admiralty Island (including the type). Specimens of *subauratus*: 107 from California (including the type). Most of these specimens are skulls. Skins examined: *phaeus*, 6; *belugae*, 3; *sagittatus*, 3; *leucodontus*, 11; *subauratus*, 39; *frondator*, 1.

Museum of Vertebrate Zoology, University of California, Berkeley, Calif.

THE MULE DEER OF SOUTHERN CALIFORNIA AND NORTHERN LOWER CALIFORNIA AS A RECOGNIZABLE RACE

By Ian McTaggart Cowan

Study of the deer of the Pacific coast district has revealed the presence of a hitherto unrecognized race of mule deer inhabiting southern California and the northern part of Lower California. The proposed name, together with a description of the new race, follows.

Odocoileus hemionus fuliginatus, new subspecies

Type.—Male, adult; skin and skull; no. 39918, Mus. Vert. Zool.; "Barona Ranch, 30 miles east of San Diego," San Diego County, California; October 8, 1928; collected by Webb Toms.

Range.—From San Jacinto and Santa Rosa Mountains, Riverside County, and San Mateo Valley, San Diego County, California, southward at least to La Corona, Sierra San Pedro Mártir, Lower California, Mexico.

Diagnosis.—Size same as that of *Odocoileus hemionus californicus* (Caton), but color darkest known in the *hemionus* group.

Color.—Winter pelage: Above, tips of hairs black; narrow subterminal bands Warm Buff to Light Ochraceous-Buff (capitalized color terms are from Ridgway, Color Standards and Color Nomenclature, 1912); bases of hairs dark gray; subterminal bands broadest on sides of body, becoming progressively narrower toward mid-dorsal line where bands may be absent, so that hairs have complete black tips. The effect is to produce an almost black mid-dorsal region extending from crown patch to rump and broadest on shoulders; crown patch Fuscous-Black, central area with slight amount of light flecking; muzzle and sides of face gray; ears gray outside, white inside; distal half of anterior margin of ear black; small blackish spot on each side of lower lip, with narrow mid-ventral line of brownish color extending anteriorly almost to margin of lip; brisket Fuscous-Black, dark color of this region extending posteriorly on to abdomen; white of under parts confined to region of genitalia; axillae and inguinal region, inside of fore leg, and inside of hind leg to hock, white, washed with pale buff; tail, below white, above black, tip black.

Summer pelage: Color of upper parts approaching Cinnamon; mid-dorsal region darkened by presence of many black-tipped hairs. Skull short; posterior end of vomer closely paralleling basisphenoid. Metatarsal gland small, averaging 82 mm.

Comparisons.—From both *Odocoileus hemionus peninsulae* (Lydekker) and *O. h. californicus* (Caton), *Odocoileus hemionus fuliginatus* can be distinguished in fresh winter pelage by darker color throughout, produced by darker hair bases and relatively longer black tips of hairs; by well defined black or blackish mid-dorsal line (occasionally present in *peninsulae*); and by broad, black dorsal line on tail, occupying the greater part of upper surface of tail. First upper premolar averaging 11 mm. wide in males; diastema of lower jaw averaging less than, rather than more than, 71 per cent of alveolar length of lower tooth row.

From *Odocoileus hemionus californicus* the present race differs as follows:

Dark spots on sides of lower lip restricted and not meeting on mid-ventral line; in summer pelage darker, Cinnamon rather than Cinnamon-Buff; dorsal area darkened by presence of many black-tipped hairs; mastoid width always less than, rather than generally greater than, least interorbital breadth; palatal breadth, as measured between alveoli of posterior molars, averaging 62 per cent rather than 74 per cent of alveolar length of upper molar series; upper molar series averaging 6 mm. greater than in *californicus* (78 mm. rather than 72 mm.).

From *Odocoileus hemionus peninsulae* the distinguishing features are as follows: Dark stripe down tail present in all specimens examined, rather than generally absent; dark patch at base of tail wanting; summer skins darker, Cinnamon, rather than between Warm Buff and Cinnamon-Buff; antorbital vacuity narrower dorsoventrally; rostrum horizontal along its lower margin rather than elevated; elevation of tip of rostrum (measured perpendicularly from a plane surface upon which the skull is resting on tips of paroccipital processes and molars) less than 36 mm., rather than greater than 42 mm.

Remarks.—In external appearance *Odocoileus hemionus fuliginatus* differs widely from either of the races adjoining it, being, in fact, the darkest of the *hemionus* group. Scanty material from appropriate areas does not serve to show intergradation with *californicus* on the one hand or with *peninsulae* on the other, nor does it make possible at this time an exact definition of range limits. A single specimen from the Santa Ana Mountains of Orange County, California, shows close approach to *O. h. californicus*.

Specimens examined.—Total number 16, as follows: California: Toro Peak, Santa Rosa Mountains, 1; Tahquitz Valley, San Jacinto Mountains, 1; San Jacinto Mountains, 1; Barona Ranch, 30 miles east of San Diego, San Diego County, 1; near De Luz, about 6 miles west of Fallbrook, San Diego County, 1; Laguna Mountains, 60 miles east of San Diego, San Diego County, 1; east side of Laguna Mountains, San Diego County, 1; Colb Valley, San Diego County, 1; San Diego County, 2. Lower California, Mexico: Vallecitos, Sierra San Pedro Mártir, 2; La Grulla trail, 6000 ft., 12 miles above San José, lat. 31°, 1; La Corona, Sierra San Pedro Mártir, 3.

Museum of Vertebrate Zoology, University of California, Berkeley, California.

REVIEW OF THE PALAEARCTIC REINDEER OR CARIBOU

By Constantine C. Flerov

In 1932 I examined the cranial characters of the Old World reindeer of the material of the Zoological Museum of the Academy of Sciences in Leningrad.[1] This collection has some new specimens of caribou from many parts of the Palaearctic region. At present it contains more than 200 specimens from Norway, Spitzbergen, Lapland, northern part of eastern Europe, Novaya Zemlya, all parts of Siberia, Altai Mountains, northern Mongolia, Transbaikalia, the Far East, Kamchatka, Saghalien, islands of Asiatic Arctic Sea, Greenland, and two specimens of *Rangifer arcticus* from Canada. The recently received specimens enable me to make some new corrections in the classification of Eurasiatic reindeer.[1a] Here I give briefly these new data. Our large collection gives an absolutely different scheme from that set forth in the very interesting monograph of Prof. Jacobi.[2] This writer made many mistakes as he worked with mixed wild and domesticated specimens. Domesticated reindeer many times were transferred from one place to another and gave many hybrids. Wild caribou form large herds which wander from south to north in summer and from north to south in winter (or from higher to lower places) but the different kinds do not intermingle.

The antlers of wild and domestic reindeer are also very different. The deer antlers generally are very variable and give no satisfactory constant characters for the classification of small groups.

Rangifer tarandus Linnaeus

1758. *Cervus tarandus* Linnaeus, Syst. Nat. ed. 10, vol. 1, p. 67.
1784. *Cervus tarandus sibiricus* Schreber, Säugethiere, vol. 5, pl. 248C.

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[1] Constantine C. Flerov. Brief outline of the classification and geographical distribution of the reindeers or caribou of the Old World. Arbeit. des Ausschusses zur Erforschung der Naturschätze, Yakutsk ser. no. 4, Publ. Acad. Sci. URSS, Leningrad, pp. 15, figs. 13. 1932.

[1a] The following names published by Millais (The Gun at Home and Abroad, 1915, vol. 4) have apparently been overlooked by the author of this paper: *Tarandus rangifer buskensis* (p. 222), from the Busk mountains, near Semipalatinsk; *T. r. chukchensis* (p. 220), the domesticated reindeer of the Chukchis of the interior of northeast Siberia; *T. r. lenensis* (p. 219), the Taimur peninsula, the Lena delta south to timber and probably east as far as Kolimsk; *T. r. yukutskensis* (p. 222), the reindeer used by the Chunchuses throughout Yakutsk, Amur region, and Transbaikal.—Editors.

[2] A. Jacobi. Das Rentier. Zoolog. Anzeiger, Ergänzungsband zu vol. 96. 1931.

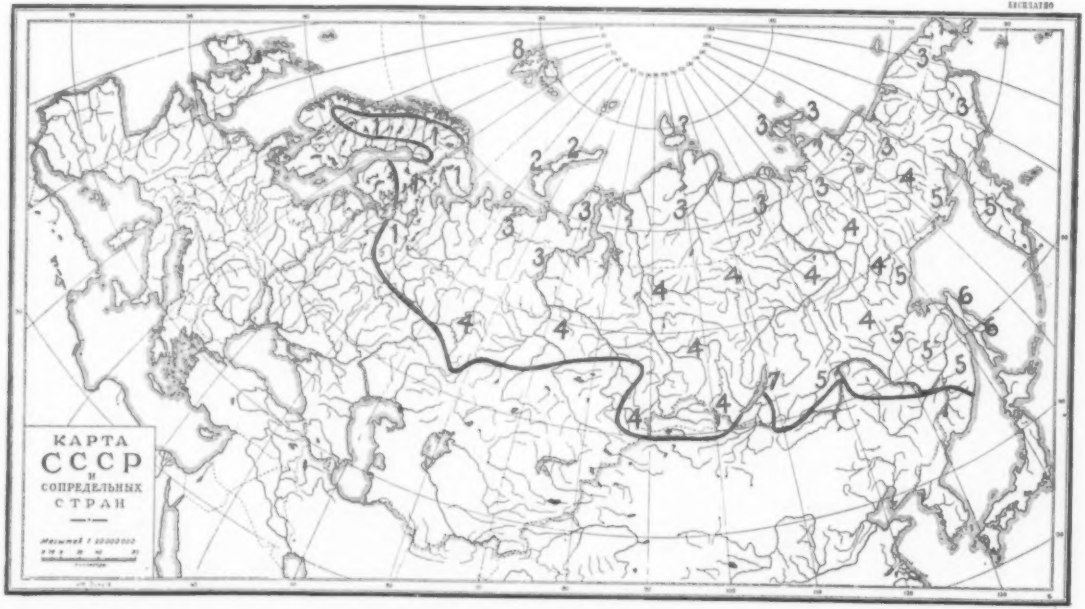

FIG. 1. MAP SHOWING SOUTHERN LIMIT OF GEOGRAPHICAL DISTRIBUTION OF REINDEER IN EUROPE AND ASIA

1. *Rangifer tarandus tarandus* Linnaeus. 2. *Rangifer tarandus pearsoni* Lydekker. 3. *Rangifer tarandus sibiricus* Murray. 4. *Rangifer tarandus valentinae* Flerov. 5. *Rangifer tarandus phylarchus* Hollister. 6. *Rangifer tarandus setoni* Flerov. 7. *Rangifer augustirostris* Flerov. 8. *Rangifer platyrhynchus* Vrolik.

1789. *Cervus tarandus, α rangifer* Gmelin, Linn.'s Syst. Nat., vol. 1, p. 177.
1822. *Cervus guettardi* Desmarest, Mammalogie, vol. 2, p. 447.
1827. *Tarandus lapponum* Billberg, Synop. Faunae Scandinav., vol. 1, p. 20.
1827. *Cervus (Rangifer) tarandus* H. Smith, Griffith's Animal Kingdom, vol. 5, p. 304.
1828. *Cervus tarandus schottingi* Sternberg, Isis, p. 482.
1835. *Rangifer tarandus* Jardine, Naturalist's Libr., Mamm., vol. 3, p. 133, pl. 6.
1836. *Tarandus rangifer* Ogilby, Proc. Zool. Soc. London, p. 134.
1842. *Tarandus borealis* Rüppell, Verzeichniss Mus. Senckenberg, vol. 3, p. 183.

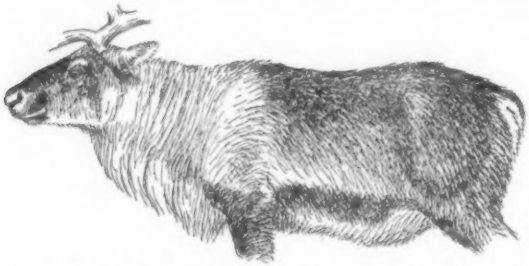

FIG. 2. *Rangifer tarandus tarandus* LINNAEUS (IN WINTER).

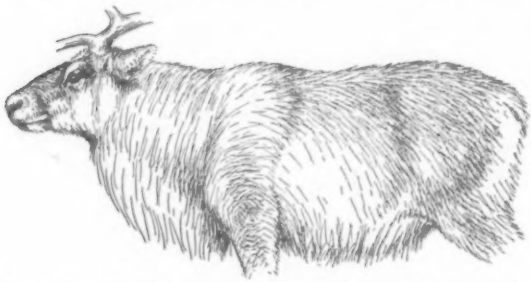

FIG. 3. *Rangifer tarandus pearsoni* LYDEKKER (IN WINTER).

1851. *Tarandus furcifer* Baird, Rep. Comm. Patents, vol. 2, Agric., p. 109.

Type.—Unknown.

Type locality.—Mountains of Swedish Lapland.

Range.—Under subspecies.

Diagnosis.—Skull moderate or large (total length: min. 335 mm.; max. 435 mm.). Rostrum wider in the region of canines than at anterior edge of nasal bones. It is broad and flat (breadth greater than height). Nasal bones little arched. Brain case a little higher than the upper side of rostral part of the skull. Interorbital region concave and upper edges of orbit a little higher than the forehead. Rostrum elongated—distance between pm^2 and the end of intermaxillary bones greater than length of molar teethrow.

Rangifer tarandus tarandus Linnaeus

Reindeer

1758. *Cervus tarandus* Linnaeus, Syst. Nat. ed. 10, vol. 1, p. 67.
1898. *Rangifer tarandus typicus* Lydekker, Deer of All Lands, p. 33.
1902. *Rangifer tarandus* var. *cylindricornis* Camerano, Mem. R. Accad. Sci. Torino, ser. 2, vol. 51, p. 167.
1909. *Rangifer tarandus fennicus*, Lönnberg, Arkiv Zool., vol. 6, no. 4, p. 10.
1912. *Rangifer fennicus* Miller, Cat. Mamm. West. Europe, p. 981.

FIG. 4. *Rangifer tarandus sibiricus* MURRAY (IN WINTER).

FIG. 5. *Rangifer tarandus valentinae* FLEROV (IN WINTER).

1915. *Rangifer tarandus tarandus* Lydekkers' Cat. Ungulate Mamm. Brit. Mus., vol. 4, p. 241.

Type.—Unknown.

Type locality.—Mountains of Swedish Lapland.

Range.—Scandinavia, Lapland, forest zone of eastern Europe.

Diagnosis.—Skull of moderate length (total length: Min. 335 mm.; med. 360 mm.; max. 400 mm.). Lacrimal of moderate length, its breadth about 50 per cent of its length. Coloring in winter intensively dark with well marked light and dark areas, the brown color of back well separated from the whitish neck, the longitudinal dark area on sides of body well contrasted dark brown in color.

Rangifer tarandus pearsoni Lydekker

Novaya Zemlya Reindeer

1902. *Rangifer tarandus pearsoni* Lydekker, Proc. Zool. Soc. London, vol. 2, p. 361.

1931. *Rangifer tarandus tarandus* Jacobi, Zool. Anzeiger, Ergänz. zu vol. 96, p. 64 (partim.).

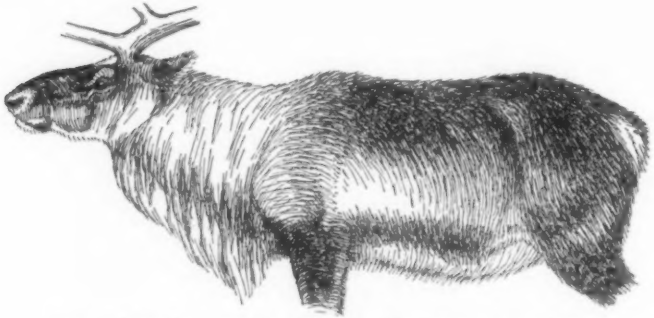

FIG. 6. *Rangifer tarandus phylarchus* HOLLISTER (IN WINTER).

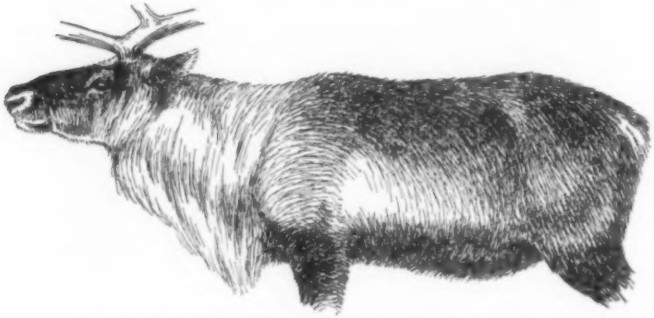

FIG. 7. *Rangifer tarandus scloni* FLEROV (IN WINTER).

1932. *Rangifer tarandus sibiricus* Flerov, Brief outline of the classification and geographical distribution of the reindeer or caribou of the Old World. Arbeit. des Ausschusses zur Erforschung der Naturschätze, Yakutsk ser., no. 4, Publ. Acad. Sci. URSS, Leningrad, p. 8 (partim.).

Type.—In the possession of H. J. Pearson, Esq., Bramcote, Nottinghamshire, England.

Type locality.—Novaya Zemlya.

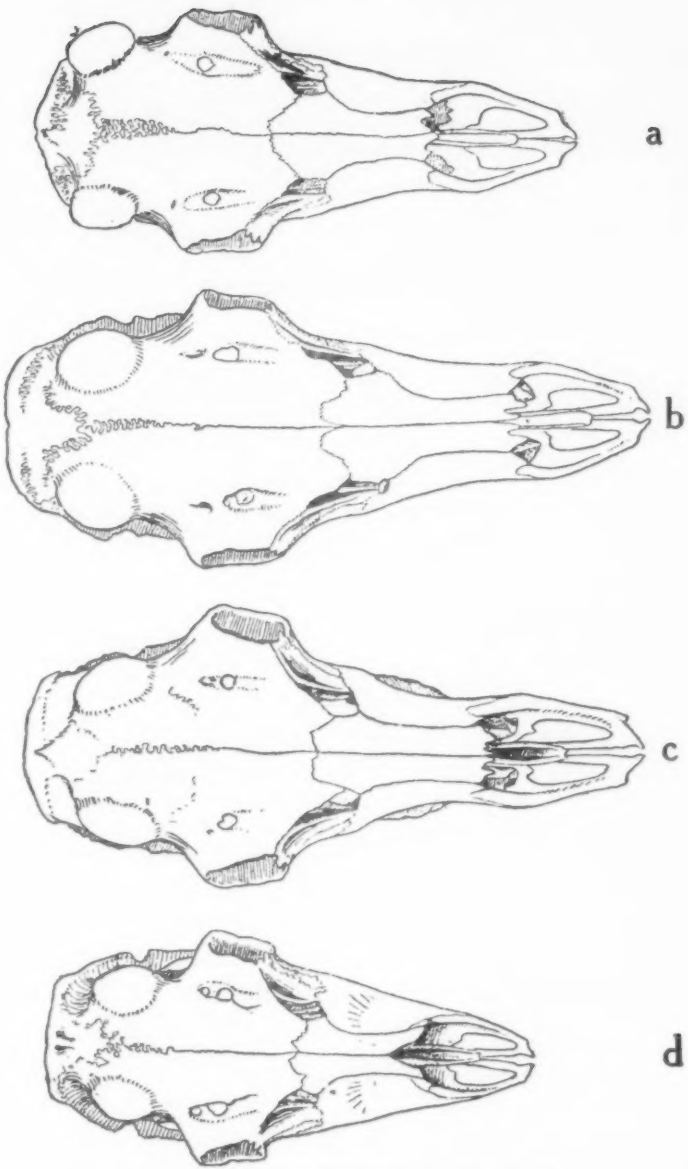

FIG. 8. SKULLS OF REINDEER. DORSAL VIEW

a. Rangifer tarandus sibiricus Murray. *b. Rangifer tarandus phylarchus* Hollister. *c. Rangifer augustirostris* Flerov. *d. Rangifer platyrhynchus* Vrolik.

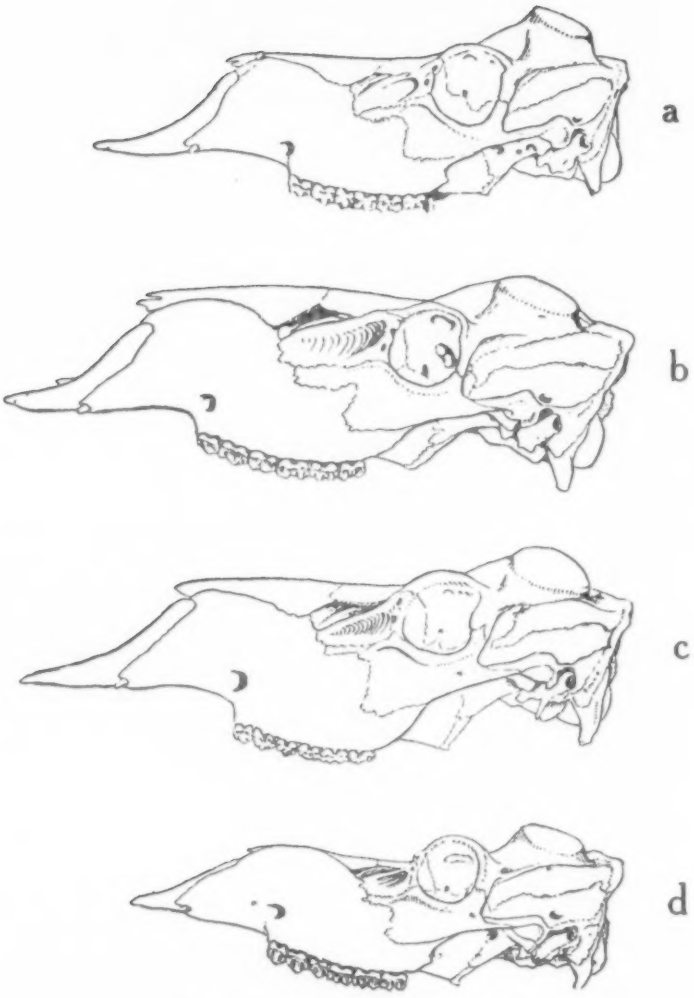

FIG. 9. SKULLS OF REINDEER. SIDE VIEW

a. Rangifer tarandus sibiricus Murray. *b. Rangifer tarandus phylarchus* Hollister. *c. Rangifer angustirostris* Flerov. *d. Rangifer platyrhynchus* Vrolik.

Diagnosis.—Skull like that of *R. tarandus tarandus* but more elongated and a little narrower. Coloring in winter very light, almost white. The light rose-brown color is present only on the upper surface of the head and back. This

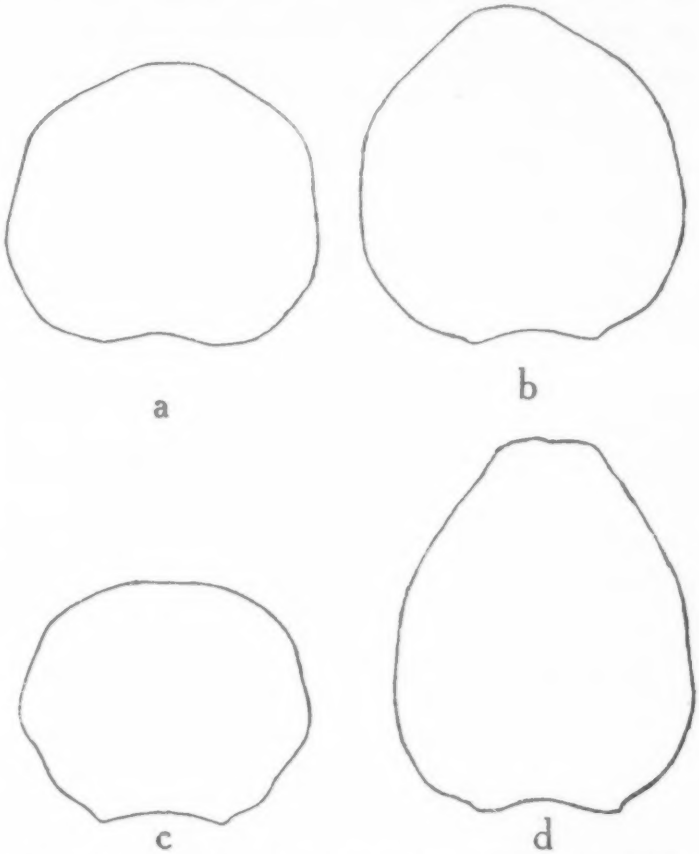

FIG. 10. TRANSVERSE SECTION OF ROSTRAL PART OF SKULLS OF REINDEER

a. Rangifer tarandus sibiricus Murray. *b. Rangifer tarandus phylarchus* Hollister. *c. Rangifer platyrhynchus* Vrolik. *d. Rangifer angustirostris* Flerov.

color but lighter is found also on the outer side of the limbs. No trace of a longitudinal dark area is present on the sides of the body. Fur very long, especially on the lower side of the neck.

Rangifer tarandus sibiricus Murray

Siberian Barren-Ground Caribou

1866. *Rangifer tarandus* var. *sibiricus* Murray, Geogr. Distr. of Mamm., p. 334 (description and figure, pp. 153, 155.).

1902. *Rangifer tarandus sibiricus* Lydekker, Proc. Zool. Soc. London, vol. 2, p. 361.

1931. *Rangifer arcticus asiaticus* Jacobi, Zool. Anzeiger, Ergänz. zu vol. 96, p. 85. (New name for *R. tarandus sibiricus*.[3])

Type.—Unknown.

Type locality.—Siberia. According to Hollister (Smithson. Misc. Coll., vol. 56, no. 35, p. 7, 1912) West Siberia, environs of Beresov.

Range.—Siberian and east European tundra zone; islands of Asiatic Arctic Sea.

Diagnosis.—Skull like that of *R. tarandus tarandus* but larger (total length: Min. 346 mm.; med. 373 mm.; max. 420 mm.) and a little longer in the rostral part. Coloring in winter whitish, as in *R. tarandus pearsoni*, but a little darker. The longitudinal brownish area on sides of body is present but not dark; fur very long especially on the lower side of the neck.

Rangifer tarandus valentinae, new subspecies[4]

Siberian Woodland Caribou

Type.—Adult male; skin no. 22599, skull no. 10214, collection Zool. Mus. Acad. Sci. Leningrad. Collected July 14, 1901 by P. G. Jgnatof.

Type locality.—Head of Chulyshman River, Northeast Altai.

Range.—Forest zone of Siberia, southward to northern Mongolia, Altai Mountains.

Diagnosis.—Skull very like that of *R. tarandus sibiricus*. Coloring in winter darker, light reddish-brown, or sandy-brown. White restricted to the belly, interior side of limbs, lower part of neck, a small rump-patch and the lower side of the tail. The brownish color of the back gradually lightens on the neck and flanks. Upper surface of the head darker than the back. The longitudinal brown area on sides of body is well marked. But in general the dark areas are not sharply separated from the light areas.

The fur, like that of *R. tarandus tarandus*, is shorter than in *R. tarandus pearsoni* and *R. tarandus sibiricus*.

Rangifer tarandus phylarchus Hollister

Okhotsk Reindeer

1912. *Rangifer phylarchus* Hollister, Smithson. Misc. Coll., vol. 56, no. 35, p. 6.

1915. *Rangifer tarandus phylarchus* Lydekker, Catal. Ung. Mamm. Brit. Mus., vol. 4, p. 245.

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[3] The type of Jacobi's new name is the pair of antlers of domesticated reindeer in the collection of the Zoological Museum, Academy of Sciences, Leningrad, no. 240–1908, collected by Buturlin in the Kolyma district, N.E. Siberia. This specimen has all the characters of the domestic form which distinguish it clearly from all wild reindeers.

[4] I give this form the name of my wife, Mrs. Valentina Laurence Flerov.

Type.—In U. S. National Museum, no. 21343.

Type locality.—Kamchatka.

Range.—Kamchatka, coast of Okhotsk Sea, Amurland.

Diagnosis.—A very large reindeer. Skull large and massive but generally very like that of *R. tarandus tarandus* (total length of skull: Min. 390 mm.; med. 414 mm.; max. 435 mm.). Rostral part long with convex profile. Nasal bones a little more arched than in the preceding form. Lacrimal bones long, their breadth less than half their length. Coloring in winter as in Seton's caribou but darker. The brown color of the back extends forward to the shoulders. The fur is shorter than in *R. tarandus sibiricus* but longer than in *R. tarandus valentinae*.

Rangifer tarandus setoni, new subspecies[5]

Seton's or Saghalien Caribou

Type.—Adult male; skin no. 2673, skull no. 6348, collection Zool. Mus. Acad. Sci. Leningrad; collected in 1892 by Dr. Suprunenko.

Type locality.—Saghalien.

Range.—Saghalien.

Diagnosis.—Closely allied to the *R. tarandus phylarchus* by its cranial characters but well distinguished from all Palaearctic wild reindeer by the dark brown color of the belly without whitish area.

Rangifer angustirostris Flerov

Bargusin Caribou

1932. *Rangifer angustirostris* Flerov, Brief outline of the classification and geographical distribution of the reindeer or caribou of the Old World. Arbeit. des Ausschusses zur Erforschung der Naturschätze, Yakutsk ser., no. 4, Publ. Acad. Sci. URSS, Leningrad, p.8.

Type.—Adult male; skin no. 20412, skull no. 10253, collection Zool. Mus. Acad. Sci. Leningrad; collected August 15, 1915, by G. Doppelmair.

Type locality.—Highlands of Bargusin Mountains, between the rivers Bolshoi Chiverkuy and Bolshaya Bannaya, northeastern coast of Lake Baikal, Siberia.

Range.—Highlands of Transbaikalia.

Diagnosis.—Skull large and elongated in its rostral part (total length: Min. 407 mm.; med. 415 mm.; max. 430 mm.). Rostral breadth above canines always greater than at anterior margin of nasal bones. Rostrum very narrow and high, its height more than its breadth. The nasal process of the maxillary bones is almost flat (all other forms have it strongly swollen). Nasal bones very much arched (as in *Cervus elaphus*), rising high above the upper edges of the maxillary bones. Rostrum gradually narrowing upwards in the direction of the nasal bones. The rostral region of the skull above the premolars is very much compressed, so that the anterior premolar can be seen when skull is viewed from above (In other forms the rostrum is so wide that this tooth can not be seen).

Coloring in winter unknown.

This species is very well distinguished from all Asiatic and European reindeer and also from the American *R. caboti* G. M. Allen.

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[5] This name is given in honor of Ernest Thompson Seton.

Rangifer platyrhynchus Vrolik

Spitzbergen Reindeer

1829. *Cervus* (*Tarandus*) *platyrhynchus* Vrolik, Nieuwe Verhandl. Kron. Nederl. Inst., Eerste Klasse, pt. 2, p. 160.

1862. *Cervus tarandus* forma *spetsbergensis* Andersén, Öfvers. Vet.- Acad. Förhandl., Stockholm, vol. 19, p. 457.

1866. *Rangifer arcticus* var. *spitzbergensis* Murray, Geogr. Distr. Mamm., p. 334, described on p. 155.

1898. *Rangifer tarandus spitzbergensis* Lydekker, Deer of All Lands, p. 41.

1902. *Rangifer spitzbergensis*, Camerano, Mem. Reale Accad. Sci. Torino, ser. 2, vol. 51, p. 159.

1912. *Rangifer platyrhynchus* Miller, Cat. Mamm. West. Eruope, p. 985.

1915. *Rangifer tarandus platyrhynchus* Lydekker, Cat. Ungulate Mamm. Brit. Mus., vol. 4, p. 243.

1926. *Rangifer tarandus spetsbergensis* Wollebaek, Resultat. Norske Statsund. Spitzbergen Expeditioner, vol. 1, no. 4.

Type.—Unknown.

Type locality.—Spitzbergen.

Range.—Spitzbergen.

Diagnosis.—Smallest of the Palaearctic reindeer (total length of skull: Min. 295 mm.; med. 318 mm.; max. 344 mm.). Rostrum short—distance between pm^2 and end of intermaxillary bones a little longer than the molar tooth row. Lacrimal bones short as in *R. tarandus tarandus*. Nasal bones very little arched and not visible when skull is viewed in profile. Interorbital part very concave, upper edges of orbits rising higher than the forehead. Braincase higher than upper side of rostrum. Rostral part bent upward and the breadth of rostrum above the canine less than above the front edge of nasal bones. Coloring in winter lighter than in *R. tarandus tarandus*.

Department of Mammals, Zoological Institution, Academy of Sciences, Leningrad, U. S. S. R.

MAMMALS COLLECTED IN JAVA, BALI, AND LOMBOK

By Nagamichi Kuroda

The following notes on the Sundanese mammals are based in part on my own collection made during my visit to Java, Bali, and Lombok in 1929, and in part on specimens presented to me by Mr. K. Yasuda of Bali Island.

In the present collection I find nothing that seems to be new to science, except a form of *Pteropus vampyrus* from Lombok, to which I am inclined to give a subspecific rank. To Mr. Yasuda of Bali my best thanks are due.

Family PTEROPODIDAE

Pteropus vampyrus vampyrus Linnaeus

A male and a female from foot of Mt. Tjikorai near Garoet, W. Java; May 22, 1929; Tsurumatsu Sato Coll., nos. 1332, 1333.

Measurements.—Nos. 1332 (ad. ♂) and 1333 (ad. ♀), respectively: Length of head and body, 310, 307 mm.; forearm, 208, 205 mm.; greatest length of skull, 85, 82 mm.; zygomatic breadth, 44, 45 mm. The maximum length of forearm reaches 220 mm. and the greatest length of skull is 91 mm. (according to Dr. K. Andersen).

Pteropus vampyrus pluton Temminck

1853. *Pteropus pluton* Temminck, Esq. Zool., p. 56. ("Bali et Lombok.")

Type locality.—It is herewith restricted to Bali.

A male subadult was taken at Singaradja, Bali, on April 22, 1931; K. Yasuda coll., no. 1393.

Measurements.—Length of head and body, 235 mm. (in skin); forearm, 181 mm.

The single specimen (without skull) agrees with the description of *pluton*; but the length of head and body, as well as that of the forearm are very much shorter, probably because the individual is immature. The coloration of mantle is dark chestnut, not contrasting with the back; crown of head distinctly blackish, nearly without sprinkling of grayish hairs; chin and throat chestnut seal-brown; chest nearly black; back, rump, and breast blackish, sprinkled with grayish or rusty hairs; ears large, broader, and less pointed than in the preceding form.

Pteropus pluton was based on three mounted specimens. The forearm measured, according to Dr. Andersen, 214 mm. (♂) and 217 mm. (♀), and the greatest length of skull measured by him was 86 mm.; zygomatic breadth, 47.5 mm. These measurements show that this subspecies, *pluton*, is larger than typical *vampyrus* from Java.

Pteropus vampyrus kopangi, new subspecies

Type.—An adult male, N. Kuroda coll., no. 1334; June 2, 1929.

Type locality.—Kopang, Lombok.

Diagnosis.—Resembles *P. vampyrus vampyrus* from Java in coloration, but the lengths of head and body, and of the forearm, are distinctly less.

Variation of coloration of pelage.—Mantle varies from pale dirty buff (♀) to chestnut-buff (♂), much paler than and strongly contrasting with the back, which varies from brownish to blackish, sprinkled with pale brown or grayish-white hairs. Breast and abdomen varying from dark russet-brown to blackish, sprinkled with pale brown hairs. The type nearly resembles typical *vampyrus* in color.

Measurements.—Nos. 1334 (♂ ad., type), 1335 (♂ ad.). and 1336 (♀ ad.), respectively: Length of head and body, 260, 280, 265 mm.; forearm, 193, 196, 187 mm.; greatest length of skull, 81, 81, 75 mm.; zygomatic breadth, 43, 47.5, 42 mm.

The skulls are generally shorter than those of typical *vampyrus*.

Remarks.—On the island of Lombok, we have two other species, *alecto* (forearm under 175 mm.) and *lombocensis* (forearm under 122 mm.), of the same genus, but they have very short forearms as compared with *P. vampyrus kopangi*.

Cynopterus brachyotis javanicus K. Andersen

A female, two males, and one young from Salenba, Weltevreden, W. Java· May 15, 1929; Tsurumatsu State coll., nos. 1344, 1345, 1346, 1347; collected by native boys.

Measurements.—Nos. 1344 (♀), 1345 (♂), 1346 (♂), respectively: Length of head and body, —, 82, 78.5 mm.; tail, —, 8, 11; ear, —, 17, 18 mm.; forearm, 59, 64.6, 66.5 mm.; third metacarpal, 40, 41.5, 42 mm.; greatest length of skull, 28, 30.5, — mm.; basilar length of skull, 24, 26.5, — mm.; zygomatic breadth, 17.5, 18.5, — mm.

Family HIPPOSIDERIDAE

Hipposideros diadema diadema (Geoffroy)

A male and a female from Salenba, Weltevreden, W. Java; May 14 and 15, 1929; Tsurumatsu State coll., nos. 1348, 1349; collected by native boys.

Measurements.—Nos. 1348 (♂), 1349 (♀), respectively: Length of head and body, 89, 90 mm.; tail, 50.5, 52 mm.; ear, 29, 30 mm.; hind foot and claw, 20.5, 17.5 mm.; forearm, 83.5, 88.5 mm.; greatest length of skull, —, 33 mm.; basilar length of skull, —, 27 mm.; zygomatic breadth, —, 18.5 mm.

Family VESPERTILIONIDAE

Pipistrellus tenuis (Temminck)

An adult female from Weltevreden, W. Java; May 13, 1929; N. Kuroda coll., no. 1350.

This is one of the smallest bats, resembling *abramus* and *pipistrellus*; the color of the fur is black. I obtained it at a shop on Weltevreden Street.

Measurements.—Length of head and body, 38.5 mm.; tail, 28 mm.; hind foot and claw, 6.5 mm.; ear, 10 mm.; tragus, 4 mm.; forearm, 30.1 mm.; greatest length of skull, 13 mm.; basilar length of skull, 10.5 mm.; zygomatic breadth, 7.5 mm.

Dobson (Cat. Chiroptera, 1878, p. 226) recorded it from Sumatra, Java, and Borneo. Dammermann (Treubia, 1929, p. 39) reported it from Java without definite locality.

Pipistrellus imbricatus (Horsfield)

Five adult females from Salenba, Weltevreden, W. Java; May 14 and also end of May, 1929; Tsurumatsu State coll., nos. 1352, 1353, 1356, 1357, 1358; collected by native boys.

Two adult males from Soekaboemi, 2300 feet alt., W. Java; June 18, 1929; N. Kuroda coll., nos. 1354, 1355.

The coloration of back is dark brown or dark chestnut, beneath grayish and paler.

Measurements (in millimeters)

NO.	SEX	HEAD AND BODY	TAIL	HIND FOOT AND CLAW	EAR	TRAGUS	FOREARM	GREATEST LENGTH OF SKULL	BASILAR LENGTH	ZYGOMATIC BREADTH
1352	♀	44	38	7	12	5.1	36	—	—	—
1353	♀	49	37.5	7	12	5.5	35	13.5	11.1	8.5
1354	♂	45	35.5	7	12.1	5.0	32.5	—	—	—
1355	♂	44	—	—	—	—	34.5	14	11.5	9
1356	♀	47	38	6.5	12.5	5	34	13.9	11.5	8.1
1357	♀	43	37.5	7	12.9	5	34	—	—	—
1358	♀	42.5	36	6	11	5	33.5	—	—	—

From the above measurements it is clear that the length of the forearm varies from 32.5 to 36 mm.; Dobson (1878) also gave it as 1.35 inch (= 34 mm.).

Besides the above adult specimens I have five young and five naked young specimens from Salenba in Weltevreden (end of May, 1929); the former specimens have nearly the same color as the adults.

The tragus of the species is very peculiar in shape; the form is crescent-shaped, with a distinct triangular projection at the base of the outer margin; the inner margin is deeply concave; postcalcaneal lobe rather small, but visible.

This small bat seems to be very common in Java where it is distributed from the low countries up to 2300 feet. It is recorded from Malacca and Sumatra, as well as Java.

Myotis muricola (Gray)

An adult female from Soekaboemi, 2300 feet alt., W. Java; May 18, 1929; N. Kuroda coll., no. 1370.

The back is black with pale tips to the hairs; below black with ashy tips to the hairs.

Measurements.—Length of head and body, 37 mm.; tail, 42 mm.; hind foot and claw, 7 mm.; ear, 11.5 mm.; forearm, 36 mm.; greatest length of skull, 13.5 mm.; basilar length of skull, 11.5 mm.; zygomatic breadth, 8 mm.

This is an oriental species, ranging from the Himalayas, India, Ceylon, to the Malay Peninsula, Sumatra, Java, Borneo, and Celebes.

CHIROPTERA
- Vespertilionidae
  - †*Eptesicus* cf. *grandis* (Brown)
  - †*Corynorhinus alleganiensis*, n.sp.

CARNIVORA
- Canidae
  - † *Canis armbrusteri* Gidley
  - † *Canis* cf. *priscolatrans* Cope
- Ursidae
  - † *Euarctos vitabilis* (Gidley)
  - ‡ *Arctodus haplodon* (Cope)
- Mustelidae
  - †*Martes parapennanti*, n. sp.
  - *Mustela* cf. *vison* Schreber
  - *Gulo* cf. *luscus* (Linnaeus)
  - †*Lutra parvicuspis*, n. sp.
  - ‡*Brachyprotoma pristina* Brown
  - †*Spilogale marylandensis*, n. sp.
  - †*Taxidea marylandica*, n. sp.
- Felidae
  - †*Felis* cf. *inexpectata* (Cope)
  - †*Felis* near *atrox* Leidy

RODENTIA
- Sciuridae
  - *Marmota monax* (Linnaeus)
  - *Citellus* cf. *tridecemlineatus* (Mitchill)
  - *Tamias* cf. *striatus* (Linnaeus)
  - †*Sciurus tenuidens* Hay
  - *Glaucomys* sp.
- Geomyidae
  - ‡*Plesiothomomys potomacensis*, n. gen. & sp.
- Castoridae
  - *Castor canadensis* Kuhl
- Cricetidae
  - *Peromyscus* cf. *leucopus* (Rafinesque)
  - †*Neotoma magister* Baird
  - ‡*Parahodomys spelaeus*, n. gen. & sp.
  - *Synaptomys* cf. *cooperi* Baird
  - *Synaptomys* (*Mictomys*) sp.
  - †*Microtus* (or *Pitymys*?) cf. *involutus* (Cope)
  - †*Ondatra* cf. *annectens* (Brown)
- Zapodidae
  - *Zapus* sp.
  - *Napacozapus* cf. *insignis* (Miller)
- Erethizontidae
  - *Erethizon* cf. *dorsatum* (Linnaeus)

LAGOMORPHA
- Ochotonidae
  - *Ochotona* sp.
- Leporidae
  - *Lepus* cf. *americanus* Erxleben

PROBOSCIDEA
- Mastodontidae
  - ‡*Mammut* cf. *americanum* (Kerr)

PERISSODACTYLA
- Equidae
  - †*Equus* sp.
- Tapiridae
  - †*Tapirus* sp.

ARTIODACTYLA
- Tayassuidae
  - ‡ *Platygonus cumberlandensis* Gidley
  - ‡*Platygonus vetus* (?) Leidy
  - ‡*Mylohyus exortivus* Gidley
  - ‡*Mylohyus* cf. *pennsylvanicus* (Leidy)
- Cervidae
  - *Cervus* sp.
  - *Odocoileus* cf. *virginianus* (Boddaert)
- Bovidae
  - ‡*Euceratherium*(?) *americanum* (Gidley)

† Extinct species.
‡ Extinct genera.

It is interesting to note that the fauna listed does not appear to be an assemblage which one might expect to find associated in a relatively small area. The environmental conditions suggested by several of the

forms recognized are incongruous with those of others and to a certain extent with conditions existing in the region of the cave today. The bats, tapir, peccaries and crocodylid taken together are suggestive of austral climatic conditions. In contrast with these are such widely distributed boreal types as wolverine, a lemming mouse of the group *Mictomys* and several rodents and carnivores. Furthermore, some seem to represent less humid conditions than others, although the greater number of forms are well suited to forest environment.

These inconsistencies may be only apparent, but they possibly indicate a period of cave entombment sufficiently long to allow important climatic changes to take place. Clearly the association is not to be accounted for by postulating greater topographic relief in the vicinity of the cave than there is today. It seems evident that the Potomac River, and the tributary Wills Creek which flows near the cave, had not at that time cut so deeply below the old upland surfaces, with the result that there was then even less relief than now.

The mammalian forms described as new are a vespertilionid bat of the genus *Corynorhinus*, four mustelids and two rodents. The two rodent types are believed to represent new genera.

Corynorhinus alleganiensis, new species

Type.—Skull, No. 12412, U. S. N. M., with incomplete dentition and lacking bullae and zygomatic arches.

Specific characters.—Skull close in size to that of *C. rafinesquii*. Frontal region not so highly inflated above dorsal plane of rostrum. Median depression in the dorsal surface of muzzle not so deep. Depth of posterior portion of skull from occipital condyles to top of interparietal less. Occipital condyles slightly farther forward. Temporal ridges do not unite posteriorly in a median ridge.

Material.—Representing *Corynorhinus alleganiensis* are five skull portions and twenty-nine lower jaw fragments. The most complete specimen is the type which is well preserved and clearly shows the proportions of the rostrum and cranium (fig. 1*a* and *b*). However, the dentition is not entire and the specimen lacks the zygomatic arches and tympanic bullae. No. 12413, U. S. N. M., is an incomplete rostral portion including all the cheek-teeth posterior to the canine in the right maxillary (fig. 1*c*) and three cheek-teeth in the left. A fragmentary third skull, No. 12415, U. S. N. M., consists of the left portion of the rostrum with the teeth, P^4 to M^3, and a part of the frontal region. The two remaining skull portions consist only of maxillary fragments and teeth. The majority of mandibles are remarkably well preserved and include a greater part of the dentition (see fig. 1*d*) although only two specimens retain the incisors.

Description.—The skull of *Corynorhinus alleganiensis* is about the size of that in the living species *C. macrotis* and *C. rafinesquii*. However, several characters are observed which clearly separate it from the nearest living forms. The most important of these are concerned with the less inflated condition of the brain case

and appear not to be due to crushing. The frontal region in *C. alleganiensis* does not project so markedly above the dorsal plane of the rostrum, consequently the dorsal profile from the nasal opening to the top of the frontals more nearly approaches a straight line. Also, the median pit or depression in the dorsal surface of the rostrum is not so deep as in *C. rafinesquii* and is not separated from the anterior nasal notch by so conspicuous a ridge. The height of the posterior portion of the cranium as measured from the occipital condyles to the top of the interparietal is noticeably less in the fossil. Furthermore, the condyles are slightly farther forward in position as indicated by the distance between the pre-

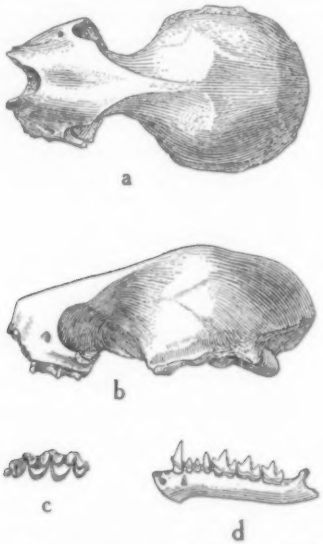

FIG. 1. *Corynorhinus alleganiensis*, new species. *a*, skull, type specimen, No. 12412, U. S. N. M., dorsal view; *b*, lateral view; *c*, upper dentition, No. 12413, U. S. N. M., occlusal view; *d*, left ramus of mandible, No. 12414, U. S. N. M., lateral view. × 3. Cumberland Cave Pleistocene, Maryland.

served condyle on the left side and the glenoid fossa. This suggests that the bullae, though not preserved in the fossil, may have been of smaller anteroposterior diameter or possibly not so well separated from the condyles. The temporal ridges at the antero-dorsal margins of the temporal fossae are distinct and converge backward but instead of uniting to form a sagittal crest continue posteriorly a short distance as nearly parallel ridges. This character was also clearly observed in a second, more incomplete skull portion of *C. alleganiensis* (No. 12415). In all specimens of *C. macrotis* and *C. rafinesquii* examined these lateral ridges unite posteriorly to form a short median ridge. Furthermore, these ridges

in *C. alleganiensis* are somewhat better defined anteriorly than in modern forms and at the termination of each is the very slightest suggestion of a postorbital process.

Corynorhinus phyllotis Allen[6] from the region of San Luis Potosi in Mexico, though defined as having a flattened braincase, is apparently a larger and broader-skulled type than *C. alleganiensis*. The rostrum of *C. phyllotis* is described as more depressed and having a more marked median excavation than other living species of *Corynorhinus*. Furthermore, the audital bullae are even larger than in the more northern species.

No important or consistent differences were observed between the dentition of *C. alleganiensis* and that of the living forms of *Corynorhinus*. Also, the lower jaws are apparently not distinguishable from those of modern forms. Although the dental formula for the lower jaw of *Corynorhinus* is the same as in *Myotis* not one of the many specimens from Cumberland Cave was found to represent the latter genus. It is probable that Gidley had reference to this *Corynorhinus* lower jaw material when he included *Myotis* in his faunal list of 1913. The mandible of *Corynorhinus* has a relatively shorter premolar series and longer molar series than does that of *Myotis*.

The presence of *Corynorhinus* in the fauna is of particular interest inasmuch as it is the first record of the genus from the Pleistocene and it adds a new and interesting species to this group of bats. Furthermore, its occurrence in western Maryland is apparently somewhat outside the recorded distribution[7] of the living species. The range of *C. macrotis* extends northward into North Carolina and the species has been recorded from the Dismal Swamp of Virginia. *C. rafinesquii* is known in southwestern Virginia, Kentucky and southern Indiana, as well as farther west.

Measurements.—First, *Corynorhinus alleganiensis*, No. 12412, U. S. N. M., type; second, *Corynorhinus rafinesquii pallescens*, No. 213367, U. S. N. M.: Length of skull from anterior margin of canine alveolus to supraoccipital, 15.75 mm., 15.9; width of postorbital constriction, 3.8, 3.75; depth of posterior portion of skull from inferior margin of occipital condyles to top of interparietal, 5.25, 6.3; distance from postglenoid process to posterior margin of occipital condyle, 5.65, 6.4; length of upper premolar-molar series, 4.4 (No. 12413), 4.5; length of lower dentition from C to M_3 inclusive, 5.9 (No. 12414), 5.8.

Martes parapennanti, new species

Type.—Anterior portion of male skull (fig. 2*a*), No. 8010, U. S. N. M., carrying most of the cheek teeth of the left side.

Material.—In addition to the type there are ten specimens in the collection, consisting of lower jaws and skull fragments with teeth. One pair of maxillaries, No. 12336, U. S. N. M., with nearly all the cheek teeth on both sides, has a fragmentary right ramus of the mandible associated.

Specific characters.—Size intermediate between *Martes pennanti* and *Martes americana*. Skull construction, as far as can be determined, nearly as in *M. pennanti*. Upper carnassial relatively shorter than in *M. pennanti* with protocone

[6] G. M. Allen, Bull. Mus. Comp. Zool., vol. 60, pp. 352–353, 1916.

[7] G. M. Allen, *ibid.*, pp. 338, 349–350.

more forward in position as in *M. americana*. Upper carnassial with uncovered and well developed external median rootlet as observed in *M. pennanti*. M^1 relatively short anteroposteriorly with metacone and cingulum posteroexternal to metacone somewhat reduced. External roots of M^1 not so distinctly separated as in *M. pennanti*. M_1 with metaconid much reduced. Mandible with low but anteroposteriorly elongate coronoid process. Masseteric fossa deeply impressed.

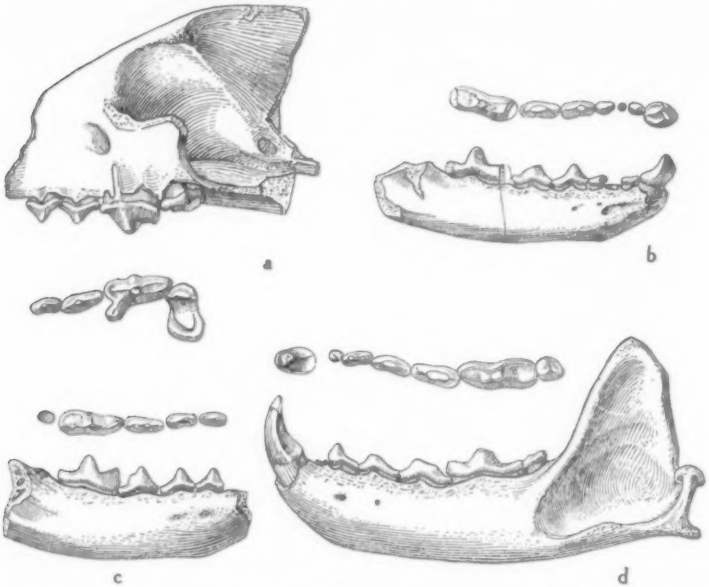

FIG. 2. *Martes parapennanti*, new species. *a*, Anterior portion of skull (male), type specimen, No. 8010, U. S. N. M., lateral view with occlusal view of dentition; *b*, right ramus of mandible (female), No. 11878, U. S. N. M., lateral and occlusal views; *c*, right ramus of mandible (female), No. 11876, U. S. N. M., lateral and occlusal views; *d*, left ramus of mandible (male), No. 11877, U. S. N. M., lateral and occlusal views. × 1. Cumberland Cave Pleistocene, Maryland.

Coronoid process with two well defined fossae, one on its external upper half, the other on its inner base. The modifications of the coronoid region are more pronounced than in living species.

In *Martes americana* and *Martes caurina* the upper carnassial is relatively short, as it is in *M. parapennanti*, but P^4 in these living forms lacks the external median rootlet characteristic of the fishers. M^1 also is relatively short anteroposteriorly in the martens and the metacone is reduced, more so than in *M. parapennanti*.

It may also be mentioned that the condyle of the lower jaw in *M. parapennanti*

is relatively narrow transversely and shallower than in the living species examined. A glenoid portion preserved with one of the specimens, No. 11959 U. S. N. M., shows a correspondingly narrow glenoid fossa and the postglenoid process curves well forward along its inner border to form an interlocking joint as in *Gulo*. In the living species of martens this joint is perfectly hinged but is not completely interlocking.

Martes diluviana (Cope)[8] from the Port Kennedy deposit in Pennsylvania has a much shallower jaw, as indicated in the two figured specimens, than male specimens of *M. parapennanti* with teeth of comparable size. The depth of the jaw is near that of a female *M. parapennanti* with teeth considerably larger. Moreover, the metaconid of the lower carnassial is apparently better developed in *M. diluviana*.

Measurements.—Type, No. 8010. U. S. N. M.: Width across postorbital processes, 28.0 mm. (approx.); least width between superior borders of orbits, 24.0 (approx.); width between outer surfaces of M^1, 32.0 (approx.): length of cheek tooth row, P^1 to M^1 inclusive, 30.5; anteroposterior diameter of P^4, 10.2; transverse width of P^4 across anterior part including protocone, 6.0; transverse width of P^4 across metacone, 3.9; anteroposterior diameter of outer lobe of M^1, 5.0; anteroposterior diameter of inner lobe of M^1, 6.0; greatest transverse diameter of M^1, 9.5.

Two paratypes: first, No. 11877 ♂, U. S. N. M.; second, No. 11878 ♀, U. S. N. M.: Length of lower jaw from anterior surface of canine at cingulum to middle of posterior surface of condyle, 68.5 mm.,—; distance from posterior surface of M_1 to posterior margin of coronoid above condyle. 28.0,—; height of coronoid above base of angle, 31.1,—; depth of jaw below heel of M_1 on external side, 12.6, 9.2; length of tooth series, C to M_1 inclusive, 40.8, 36.5 (approx.); anteroposterior diameter of P_4, 7.9, 6.4; greatest transverse diameter of P_4, 3.3, 2.6; anteroposterior diameter of M_1, 12.7, 10.5 (approx.); transverse width of trigonid of M_1, 4.6, 3.6; transverse width of talonid of M_1, 4.7,—.

Lutra parvicuspis, new species

Type.—Portion of a broken and crushed skull (fig. 3). No. 8213, U. S. N. M., in which the principal cheek teeth of both sides are present. P^1, the canines and incisors are represented by their alveoli.

Specific characters.—Size somewhat larger than *Lutra canadensis*. Main outer cusps of cheek teeth relatively lower and less robust than in *L. canadensis*. P^2 and P^3 large with conspicuous posterointernal basin. P^4 triangulate with its base relatively wide anteriorly and with its anterior border forming a right angle with the outer border of the tooth. P^4 long and outer wall of M^1 relatively short anteroposteriorly as compared with *L. canadensis*. M^1 with paracone and metacone subequal and both cusps with relatively narrow extension of the basal portions of their outer walls.

Comparison.—The Cumberland Cave specimen represents an extinct species of otter intermediate in size between *L. canadensis* of the eastern United States and *L. felina* or *L. paraensis* of Chile and Honduras respectively. Judged by their alveoli the canines of the Cumberland Cave specimen are relatively robust, as in

[8] E. D. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 11, pp. 228–229, plate 18, figs. 5–5a, 1899.

the living species of Central and South America. The backward extension of the protocone shelf of the carnassial and of M^1 is more expanded postero-externally, while the postero-internal shelf of the premolars is somewhat more expanded than in the living species of North America. The posterior margin of the upper molar, as in some South American specimens, is not so deeply notched postero-internal to the metacone, as noted in *L. canadensis*. Perhaps the chief mark of distinction observed in the dentition of *L. parvicuspis* is the distinctly narrow proportions of the external cusp rows of P^4 and M^1.

It is interesting to note that although *L. parvicuspis* is distinct from both North American and South American otters it approaches living species of South America in several of those characters in which it differs from northern forms. Most noticeable among these are the size of the skull and canines, the development of the upper premolars and the somewhat smaller relative size of the molar.

A comparison of *L. parvicuspis* with *L. rhoadsii* Cope[9] from Port Kennedy, Pennsylvania, is difficult on account of the different nature of the materials preserved. *L. rhoadsii* was based on lower jaws and a single upper molar. The di-

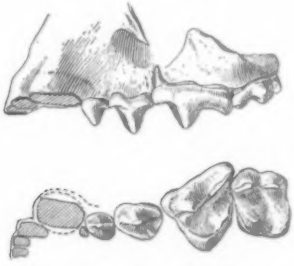

FIG. 3. *Lutra parvicuspis*, new species. Maxillary portion of skull with premolar and molar teeth, type specimen, No. 8213, U. S. N. M., lateral and occlusal views. × 1. Cumberland Cave Pleistocene, Maryland.

mensions given by Cope for the anteroposterior diameter of the lingual portion of M^1 shows this tooth to be much smaller than in *L. parvicuspis*.

Lutra piscinaria Leidy[10] from the late Pliocene or early Pleistocene of Idaho is a considerably larger form as indicated by the size of the tibia.

Measurements.—First, *Lutra parvicuspis*, No. 8213, U. S. N. M., type; second, *Lutra canadensis*, No. 197943, U. S. N. M.; third, *Lutra felina*, No. 35377, U. S. N. M.: Length of cheek tooth series, P^1 to M^1 inclusive, 34.5 mm. (approx.), 30.0, 33.6; anteroposterior diameter of canine at alveolus; 7.7 (approx.), 5.5, 7.6; anteroposterior diameter of P^2; 5.0, 5.0, 5.0; greatest transverse diameter of P^2, 4.0, 3.3, 4.3; anteroposterior diameter of P^3, 7.7, 7.5, 8.2; greatest transverse diameter of P^3, 5.3, 5.0, 6.0; anteroposterior diameter of P^4, 12.8, 11.5, 14.5; great-

[9] E. D. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 11, pp. 238–239, 1899.

[10] Joseph Leidy, Report, U. S. Geol. Surv. Terrs., pp. 230–231, 316, 1873.

est transverse diameter of P^4 perpendicular to outer wall, 10.2, 9.6, 11.5; anteroposterior diameter of M^1 across outer cusps, 8.0, 8.7, 8.3; anteroposterior diameter across inner portion of M^1, 8.7, 8.0, 8.5; transverse diameter across paracone and protocone of M^1, 10.5 11.0, 11.8.

Spilogale marylandensis, new species

Type.—Right ramus of mandible (fig. 4), No. 12048, U. S. N. M., with canine and P_3 to M_1 preserved.

Specific characters.—Mandible about the size of that in *Spilogale putorius*. Symphysis abrupt and inferior margin of mandible less convex longitudinally. Canine slender and long. Third and fourth premolars and molar slender and not overlapping. P_3 small. Basal portion of P_4 nearly oval in cross-section as seen in dorsal view. Trigonid of M_1 relatively short and narrow. Metaconid moderately well developed but not so distinctly separated from protoconid as in *S. putorius*. Buccal surface of talonid not offset inwardly to so great an extent as in living species.

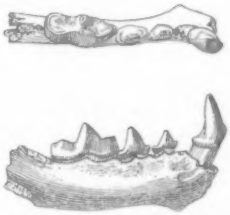

FIG. 4. *Spilogale marylandensis*, new species. Right ramus of mandible, type specimen, No. 12045, U. S. N. M., lateral and occlusal views. × 1½. Cumberland Cave Pleistocene, Maryland.

Comparison.—*Spilogale marylandensis* compares favorably in size and depth of jaw with female specimens of *S. putorius*. However, the symphysis of the mandible is somewhat more abrupt than in either male or female specimens and projects downward to a noticeable extent giving the lower margin of the ramus a less convex and more irregular longitudinal profile. The premolars are narrower and even less crowded than is common in the living species. The trigonid of M_1 is slightly shorter and narrower than in either *S. putorius* or *S. interrupta*, and the external wall of the heel is not offset inward so abruptly from that of the trigonid as in the living species. Furthermore, the metaconid of M_1 is more solidly united with the protoconid, however, this cusp is not reduced as in *Brachyprotoma*.

Spilogale marylandensis does not differ greatly in size from *Brachyprotoma pristina* but has smaller, more slender premolars and a larger carnassial. Other characters separating the two forms are those which distinguish *Brachyprotoma* from *Spilogale*, such as the crowding or overlapping of the premolars and smaller size of heel and more reduced metaconid of the lower carnassial.

Measurements.—First, *Spilogale marylandensis*, No. 12048, U. S. N. M., type; second, *Spilogale putorius*, No. 42892 ♂, U. S. N. M.; third, *Spilogale putorius*, No.

43719 ♀, U. S. N. M.: Depth of ramus below P_3, 5.5 mm., 6.0, 5.5; depth of ramus below posterior portion of M_1, 4.4, 5.0, 4.4; length of dentition, C to M_1 inclusive, 18.3, 18.5, 18.1; anteroposterior diameter of P_3, 2.6, 2.8, 2.9; greatest transverse diameter of P_3; 1.7, 2.1, 1.9; anteroposterior diameter of P_4; 3.4, 3.6, 3.3; greatest transverse diameter of P_4, 2.1, 2.4, 2.3; anteroposterior diameter of M_1, 7.4, 7.4, 7.6; anteroposterior diameter of trigonid of M_1, 4.4, 4.7, 4.8; greatest transverse diameter of trigonid of M_1, 3.1, 3.5, 3.4; transverse diameter of talonid of M_1, 3.0, 3.1, 3.1.

Taxidea marylandica, new species

Type.—A complete skull and lower jaws (figs. 5 and 6), an articulated series of eleven vertebrae in which all the cervicals and four dorsal are present and the proximal half of the right humerus of one individual, No. 7990, U. S. N. M.

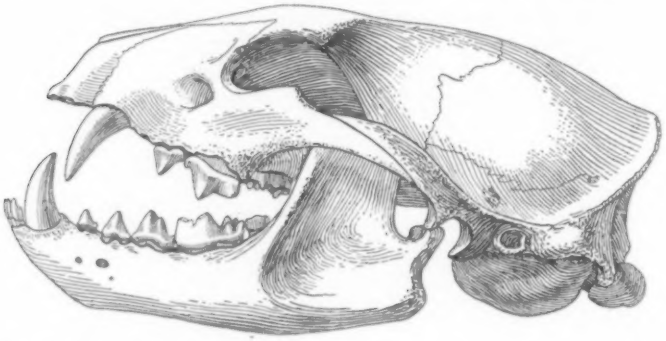

FIG. 5. *Taxidea marylandica*, new species. Skull and mandible, type specimen, No. 7990, U. S. N. M., lateral view. × ¾. Cumberland Cave Pleistocene, Maryland.

Specific characters.—Size large, about equalling the largest living race of *Taxidea taxus*. Cheek teeth relatively large. Upper carnassial with both protocone and hypocone having low regularly cone-shaped contours with circular bases; hypocone relatively large. M^1 complex in structure, with the five principal cusps (paracone, metacone, protocone, hypocone and metaconule) low, regularly cone-shaped and subequal. This tooth in consequence has a more flat appearance than is usual in the living species. It is also more expanded postero-internally so that the general outline of this tooth is not triangular, as is usual in the living species, but subquadrangular. Lower P_4 is relatively long with well developed heel and the cusps of M_1 are distinctly robust.

The skull, in general appearance, is very like that of *T. taxus*, but it presents a few peculiarities which seem to distinguish it from any living species. Viewed from the side the region above the orbit is high-arched; the occiput is relatively depressed; and the postorbital zygomatic process is relatively low. In the basi-

cranial portion of the skull the bullae appear to be more swollen and more evenly rounded than is usual in the living species. In superior view the principal differences to be noted are the slight development of the postorbital processes of the frontals as compared with recent skulls in the same stage of maturity and especially the form and size of the nasals. These are broad in midregion so that the outer sides run nearly parallel for a considerable distance instead of converging V-shaped backward as is usual in the living species. Thus the points of the

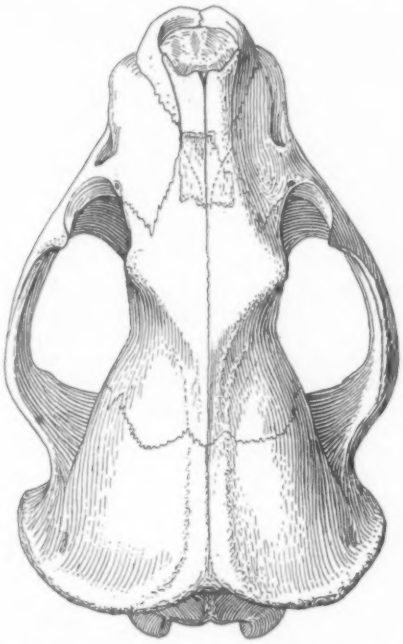

FIG. 6. *Taxidea marylandica*, new species. Skull, type specimen, No. 7990, U. S. N. M., dorsal view. × ¾. Cumberland Cave Pleistocene, Maryland.

anterior extension of the frontals are very definitely farther apart than in any specimen of the living species observed.

It is interesting to note that badgers today are considered strictly western in habitat and that, in this country, they are now not found in any numbers east of the Mississippi River.

Badgers from the Pleistocene of North America are relatively little known. *Taxidea robusta* described by Hay[11] from Arizona is known only from an ulna and

[11] O. P. Hay, Proc. U. S. Nat. Mus., vol. 59, pp. 631–632, 1922.

part of an innominate bone. A specimen of *T. taxus*, originally described by Cope[12] as *T. sulcata*, is recorded from the Pleistocene of Washington. Cope also recognized the modern species in the Port Kennedy[13] fauna.

Measurements.—First, *Taxidea marylandica*, No. 7990, U. S. N. M., type; second, *Taxidea taxus*, No. 84562, U. S. N. M.: Total length of skull including condyles, 129.3 mm., 130.0; width across mastoids, 77.0, 73.5; width across zygomatic arches, 81.2, 78.7; width of muzzle across canines, 36.3, 35.7; width of muzzle at infraorbital foramina; 34.2, 34.3; width between orbits, 30.0, 27.5; width across postorbital processes, 33.0, 33.8; width across postorbital constriction, 30.0, 30.0; depth of skull at bullae, 51.5, 56.5; depth of occiput, 42.5, 45.5; width of nasals at posterior points of premaxillaries, 10.7, 10.7; width of nasals at anterior points of frontals, 10.7, 6.5; anteroposterior diameter of P^4 along outer wall, 12.5 (approx.), 12.2; transverse diameter of P^4 perpendicular to outer wall, 10.5 (approx.), 10.8; greatest diameter of M^1, 14.0 (approx.), 14.0; transverse diameter of M^1 perpendicular to postero-external wall, 10.0 (approx.), 9.4; length of lower tooth series, C to M_2 inclusive, 50.5, 52.5; length of lower cheek tooth series, P_2 to M_2, 40.0, 41.2; anteroposterior diameter of P_4, 9.0, 7.9; anteroposterior diameter of M_1, 14.3, 15.0; anteroposterior diameter of heel of M_1, 5.2, 5.2.

Plesiothomomys potomacensis, new genus and species

Type.—Portion of left ramus of mandible (fig. 7), No. 8166, U. S. N. M., with all cheek teeth. Incisor not preserved beyond margin of alveolus.

Generic characters.—Anterior margin of symphysis of mandible very abrupt. Pit on lingual side and at base of ascending ramus shallow, as in *Thomomys*. Masseteric crest nearly straight and extending high on mandible anteriorly. Lower molars oval in cross-section and with enamel plates on anterior and posterior surfaces.

Specific characters.—Size near that in average adult specimens of *Thomomys fulvus*. Mandible robust with deep symphysis. Incisor relatively wide with anterior surface smooth and rounded. Lower cheek teeth relatively narrow transversely.

The pocket gopher material in the Cumberland Cave collection referred to this species includes four other lower jaws, one of which, No. 12049, U. S. N. M., possesses a complete lower dentition.

Comparison.—These specimens present several interesting characters which seem to separate them clearly from both *Thomomys* and *Geomys*. The mandibles are remarkably deep and the symphysial portion is turned upward rather abruptly, causing the nearly straight anterior margin of the symphysis to form a sharp angle with the inferior margin of the ramus. Also, the noticeably straight masseteric crest rises anteriorly at a higher angle from the lower border of the jaw than in living forms, making the distance between the anterior extremity of the masseteric crest and the ventral limit of the symphysis relatively great.

The dentition of these specimens is unique in combining characters of both *Thomomys* and *Geomys*. The incisor has its anterior surface rounded as in *Thomomys*, but is relatively wide. P_4 has its enamel plates as in both *Thomomys*

[12] E. D. Cope, Proc. Amer. Philos. Soc., vol. 17, p. 227, 1877.

[13] E. D. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 11, p. 239, 1899.

and *Geomys*, but the columns of this tooth are well rounded and the internal re-entrant fold is compressed, suggesting *Geomys*. The external fold is more open. The molars are widely oval in shape, perhaps even less compressed anteroposteriorly than is common in *Geomys*. In *Thomomys* these teeth have their lingual portion tightly compressed and their buccal surface distinctly flattened and usually grooved longitudinally. However, the molars in the fossil specimens have enamel developed on both anterior and posterior surfaces as in *Thomomys*. In *Geomys* only the posterior surface of these teeth has an enamel plate.

Thomomys orientalis Simpson[14] from Saber-tooth Cave in Florida, although possessing characters that ally it to *Thomomys*, apparently should be included in the new genus *Plesiothomomys*. The upper incisor in the Florida specimen shows a single shallow groove placed well toward the inner margin of the enamel as in some modern species of *Thomomys*. Also, both P^4 and M^1 have the enamel complete across the posterior surface as in the western gopher. However, the columns of these teeth are oval in cross-section as in *Geomys* and the re-entrant folds in P^4 are not so widely open as they are in *Thomomys*. Another interesting character observed in the type of *P. orientalis* is that the rostrum appears to be somewhat

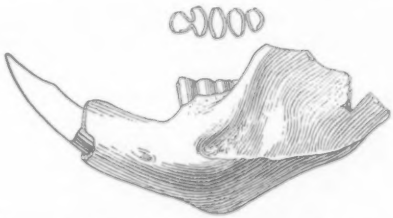

FIG. 7. *Plesiothomomys potomacensis*, new genus and species. Left ramus of mandible, type specimen, No. 8166, U. S. N. M., lateral and occlusal views. × 2. Cumberland Cave Pleistocene, Maryland.

depressed anteriorly. This may be due in part to crushing, but the portion of the palate between the cheek teeth and incisors does not seem to ascend so steeply as in living species.

P. orientalis is a distinctly smaller species with smaller teeth than *P. potomacensis*, corresponding more nearly in size to specimens of *Thomomys fossor*.

Measurements.—Plesiothomomys potomacensis; first, No. 8166, U. S. N. M., type; second, No. 12049, U. S. N. M.: Distance between lowest point on dorsal surface of mandible anterior to P_4 and ventral extremity of symphysis, 9.0 mm., 8.5; length of diastema between I and P_4, 8.1 (approx.), 8.6; length of lower cheek tooth series measured at occlusal surface, 7.0, 7.6; anteroposterior diameter of lower incisor,—, 2.3; transverse diameter of lower incisor, 2.1, 2.2; anteroposterior diameter of P_4 at occlusal surface, 2.6, 2.8; transverse diameter of anterior lobe of P_4, 1.3, 1.4; transverse diameter of posterior lobe of P_4, 2.0, 2.1; anteroposterior diameter of M_1 at occlusal surface, 1.4, 1.5; transverse diameter of M_1, 2.0, 2.2;

[14] G. G. Simpson, Amer. Mus. Novitates, No. 328, pp. 6–7, 1928.

anteroposterior diameter of M_2 at occlusal surface, 1.5, 1.6; transverse diameter of M_2, 1.9, 2.1; anteroposterior diameter of M_3 at occlusal surface, 1.5, 1.6; transverse diameter of M_3, 1.7, 1.9 (approx.).

Parahodomys spelaeus, new genus and species

Type.—Portion of the right ramus of a mandible (young individual), No. 12040, U. S. N. M., (fig. 8) with all cheek teeth and part of alveolus for incisor.

Generic characters.—Cheek teeth in general structure as in *Hodomys*, but with re-entrant valleys, especially the external ones, shallower and directed nearly at right angles to the line of the tooth row. [They are directed more obliquely for-

FIG. 8. *Parahodomys spelaeus*, new genus and species. Right ramus of mandible, type specimen, No. 12040, U. S. N. M., lateral and occlusal views. × 2. Cumberland Cave Pleistocene, Maryland.

FIG. 9. *Parahodomys spelaeus*, new genus and species. Right ramus of mandible, No. 12037, U. S. N. M., lateral and occlusal views. × 2. Cumberland Cave Pleistocene, Maryland.

ward in *Hodomys*.] Anteroexternal valley of M_1 and M_2 very shallow and absent in M_3. [In *Hodomys* M_2 has a shallow but well defined anterior re-entrant in young specimens.] M_3 with a well defined posterointernal re-entrant valley. [This fold is absent in *Hodomys*.]

As seen in mandibles No. 12037 (fig. 9), U. S. N. M., and No. 12041, U. S. N. M., the following additional characters appear as of generic importance. Symphysis relatively deep. Lower branch of masseteric ridge very prominent and sharply defined. Condyle relatively large and depressed so that condylar bar is directed backward to a much greater extent than in *Hodomys* and the notch between it and the coronoid process is much more widely open.

Specific characters.—Size about that of *Hodomys alleni*. Incisors relatively robust, causing a more prominent swelling of the lower border of the ramus than

in *H. alleni*. Diastema between incisor and cheek teeth long. Posteroexternal re-entrant folds in all molars shallow and pocketed at base, wearing at occlusal surface in wide open U-shaped pattern from summit to base of crown. Posterointernal re-entrant fold well developed in M_3, extending somewhat below middle of crown but disappearing in old age.

The material referred to this form includes seven lower jaws in addition to the type, representing individuals in several stages of maturity.

Comparison.—The genus here described is known only from lower jaws but fortunately these reveal diagnostic characters that clearly distinguish it from the nearest related living genera, *Neotoma* and *Hodomys*. Of these the most readily determinable characters are to be found in the last lower cheek tooth. In old individuals, showing well worn teeth, this tooth in fossil as well as in living genera, has but two re-entrant angles, one on the inner, the other on the outer face of the crown. In *Neotoma* these re-entrant valleys are oppositely placed and tend to divide the crown surface into two subequal areas. In *Hodomys* and *Parahodomys* the re-entrants alternate, the inner being well in advance of the outer one, tending to form a more or less S-shaped enamel pattern on the triturating surface. However, the latter genera are readily distinguished from each other by the fact that in *Parahodomys* the re-entrant valleys are directed almost at right angles to the longitudinal plane of the tooth row, while in *Hodomys* they slant well forward. In young individuals with slightly worn teeth, additional distinctions are apparent in that there is present a third re-entrant fold in this posterior molar in all three genera, but this fold is peculiarly situated in the fossil form. In *Parahodomys* it occurs on the posterior internal lobe opposite the large external fold and extends downward to a point slightly below the middle of the crown. In *Neotoma* and *Hodomys* the third re-entrant fold is on the anterior lobe of the outer side. It occurs only very near the summit of the tooth in *Neotoma* but it extends down to about the middle of the tooth crown in *Hodomys*.

Measurements.—First, *Parahodomys spelaeus*, No. 12040, U. S. N. M., type; second, *Parahodomys spelaeus*, No. 12037, U. S. N. M.; third, *Hodomys alleni*, No. 91525, U. S. N. M.: Length of cheek tooth row measured at alveolar borders, 9.5 mm., 9.5, 10.8; anteroposterior diameter of M_1, 3.2,—, 3.6; transverse diameter of M_1, 2.0, —, 2.3; anteroposterior diameter of M_2, 2.8, 3.0, 3.5; transverse diameter of M_2, 2.1, 2.4, 2.5; anteroposterior diameter of M_3, 2.4, 2.5, 2.9; transverse diameter of M_3, 2.0, 2.0, 2.1; total length of jaw, condyle to incisor border, —, 30.0, 28.7; depth of symphysis; —, 5.4, 4.0; depth of ramus at point between M_2 and M_3, —, 7.3, 6.5; height of condyle above level of cheek tooth row, —, 7.0, 10.0.

U. S. National Museum, Washington, D. C.

ARRANGEMENT OF THE OBTURATOR MUSCLES, WITH NOTES ON THE OTHER MUSCLES OF THE THIGH, IN THE DWARF WAPITI (CERVUS NANNODES MERRIAM)

By E. Raymond Hall and Alden H. Miller

Several years ago an examination of Windle and Parsons' paper "On the muscles of the Ungulata" (Proc. Zool. Soc. London: 1901, pp. 656–704, text figs., 86–90; 1903, pp. 261–298, text figs., 24–27) showed (1903, p. 269, and table facing p. 297) that doubt existed as to the arrangement of the obturator muscles in the Cervidae. Because of this lack of information, we took the opportunity to investigate these muscles in an adult male wapiti (*Cervus nannodes* Merriam) recently received at the Museum of Vertebrate Zoology from the Elk Hills of Kern County, California.

Briefly stated, the question at issue was whether or not, in the Cervidae, the obturator externus passes through the obturator foramen and usurps, on the medial face of the innominate, a large part of the area from which the obturator internus usually originates. Windle and Parsons suggested that the obturator externus would be found to pass through the foramen in the case of the Cervidae as it does in other Artiodactyla studied in this connection. The results of our dissection have proved the correctness of the suggestion of these authors.

In our specimen of *Cervus nannodes* the obturator internus took origin entirely from the lateral face of the horizontal ramus of the ischium (see fig. 1). The insertion was by tendon into the trochanteric fossa of the femur in common with the obturator externus. The innervation was by way of a branch from the sacral plexus. This origin, entirely from the lateral face of the ischium, is in marked contrast to the place of origin found in most groups of mammals. In these, the muscle originates from the medial side of the ischium and passes up over the dorsal border of the ischium to its insertion. As suggested by Windle and Parsons the unusual manner of origin in the Artiodactyla probably results from the usurpation by the obturator externus, or combined obturator externus and obturator tertius, of the usual area of origin on the medial side of the pelvis.

The obturator externus in *Cervus nannodes* took origin from the lateral face of the pubis and ischium ventral to the obturator foramen, from the border of the obturator foramen except for the anterior border and the anterior third of the superior border, and from the inner face of the innominate bone where the muscle covers an extensive area on three sides of the obturator foramen. The area anterior to the obturator foramen

did not give origin to the muscle. The innervation was by way of the obturator nerve. No division was noted in the muscle which would justify recognition of an obturator tertius.

Thus, we are able to affirm that, in this representative of the family Cervidae, the obturator muscles have the same general arrangement as Windle and Parsons describe in the chevrotain, ox, sheep, goat, pig, duiker-bok, harnessed antelope and *Hyrax*.

OTHER MUSCLES OF THE THIGH

In dissecting the muscles superficial to the obturators, opportunity was taken to note the condition of other thigh muscles of this species whose musculature seems never to have been described.

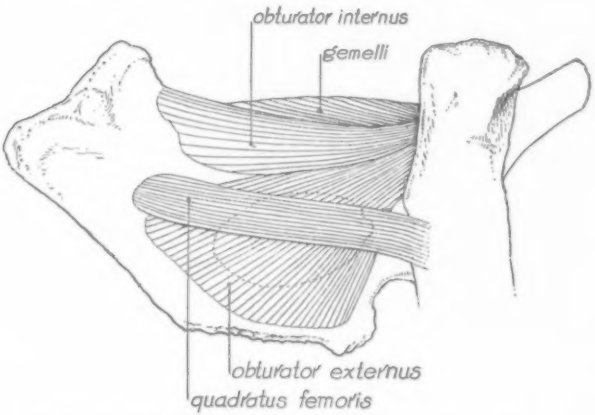

FIG. 1. OBTURATOR MUSCLES OF *Cervus nannodes* OF RIGHT SIDE VIEWED FROM POSTEROLATERAL ANGLE. × ½

M. quadriceps extensor cruris.—The rectus femoris division originated by two heads: one dorsal to the anterior half of the acetabulum, and one from a pit, on the ventral face of the ilium, anterior to the acetabulum.

M. sartorius.—This muscle took origin from fasciae covering the insertion of the psoas minor and from Poupart's ligament. The insertion was by fasciae into the upper and medial part of the tibia. The fasciae of the insertion were continuous with the sheet by which the gracilis was inserted.

M. tensor fasciae latae.—This was well developed, with an origin from the iliac crest and an insertion into the fasciae latae of the thigh.

M. gluteus medius.—This muscle was larger than the gluteus maximus. The origin was from the greater part of the gluteal surface of the ilium as far as the greater sciatic notch and along the entire anterodorsal margin of the ilium. The

insertion was on the posterior half of the lateral face of the greater trochanter, on the posterior margin of the greater trochanter, and on a V-shaped area on the medial side of the greater trochanter above the trochanteric fossa.

M. gluteus minimus.—The origin was by fleshy fibres from the ventral part of the gluteal surface of the ilium. The insertion was by a flat tendon, 26 mm. wide, on the lateral face of the ventral margin of the greater trochanter. The gluteus minimus was throughout distinct from the other gluteal muscles.

M. scansorius (gluteus ventralis).—This originated from much of the lateral face of the neck of the ilium. The insertion was by a flat tendon, 12 mm. wide, on the lateral face of the femur immediately below the insertion of the gemelli

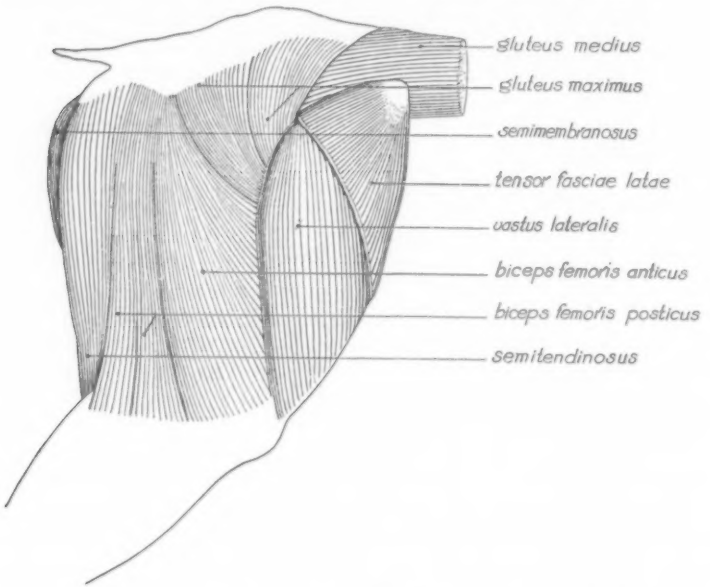

FIG. 2. SUPERFICIAL MUSCLES OF THIGH OF *Cervus nannodes*. × ⅓

M. gluteus maximus.—The origin was by fasciae from the sacral spine and first two caudal spines. The insertion was into the fasciae of the thigh overlying the vastus lateralis. The muscle was separable, with difficulty, from the biceps femoris anticus.

M. piriformis.—The piriformis was not distinguishable as a separate muscle in the gluteal mass.

M. biceps femoris anticus? (femoro-coccygeus).—This took origin entirely from the ischial tuberosity and not from the sacral or caudal spines. The insertion was by fasciae overlying the vastus externus along the anterior border of the muscle and by tendinous fasciae to the patella.

M. tenuissimus.—Though looked for, this muscle was not found.

Mm. gemelli.—The origin was from the lateral part of the fasciae connecting the sacral and caudal vertebrae with the ischium and posterior part of the ilium and from the dorsal half of the innominate bone along the middle two-thirds of the distance between the greater sciatic notch and the lesser sciatic notch. The insertion was by a flat tendon, 28 mm. wide on the anterolateral face of the base of the greater trochanter. No separation into parts could be found. Although the posterior border of the gemelli was closely associated with the anterior border of the obturator internus, the two were distinct at the insertion and could be separated with ease throughout.

M. quadratus femoris.—This muscle took origin from the lateral face of the ischium and was inserted by a flat tendon on the posterior face of the lesser tuberosity and along a narrow line above it. The innervation noted was by a branch from the sacral plexus which passed through the obturator internus before reaching the quadratus femoris.

M. semitendinosus.—The origin was by a single head from the ischial tuberosity and the insertion was into the second quarter of the internal border of the tibia with a small expansion of fasciae extending to the sheath of the tendon of Achilles.

M. semimembranosus.—There was only one ischial head and the separation of a presemimembranosus was apparent only within three and one-half inches of the insertion. Otherwise, with respect to the origin and insertion, the description by Windle and Parsons applied to our specimen.

M. biceps femoris posticus (biceps of Windle and Parsons).—The muscle originated on the ischial tuberosity and was inserted by a sheet of fasciae, continuous with that from the biceps femoris anticus, on the lateral side of the tibial portion of the leg.

Mm. adductores femoris.—This mass had no well marked divisions that would permit of distinguishing the three divisions which conform to the condition in man.

M. gracilis.—The description given by Windle and Parsons (*op. cit.*, 1903, p. 274) of the condition usually met with in the Ungulata applied to the specimen dissected by us.

M. pectineus.—The origin was from the iliopectineal line and the insertion was on to the middle third of the femur.

Museum of Vertebrate Zoology, Berkeley, California.

A FRACTURED FEMUR OF THE ALASKAN RIVER OTTER

By Edna M. Fisher

In working over the skeletal collection of *Lutra canadensis periclyzomae* in the Museum of Vertebrate Zoology, University of California, I found an interesting case of a fractured femur (M. V. Z. No. 4338), where the fracture had been complete and the healing still incomplete.

The bones under consideration are those of a male adult otter taken on May 18, 1908, by Mr. A. Hasselborg on the Anklin River, Yakutat Bay, in southeastern Alaska. Only the leg bones were saved and all of these appear to be perfectly normal, with the exception of the left femur.

The original break would seem to have been completely through the femur at the distal end, and at a slight angle, from a more distal point on the medial side to a more proximal point laterally. In the process of healing and continued use the pull of the muscles was sufficient to displace the distal portion from the normal position to one much more lateral and proximal. The shift in position not only shortened the leg considerably, 1.85 cm., and broadened the knee region but changed the distal end so that its median line forms an angle of approximately 25 degrees with the median line of the main or original shaft. This in turn placed the remainder of the leg at a like angle, but the shift does not show its effect on any of the more distal bones.

The fossae for the attachment of the tendons of various muscles are somewhat roughened and deepened, especially the fossae for the origin of the heads of the gastrocnemius and the fossae for the insertion of the adductor longus, adductor femoris and the popliteus tendon. The intercondylar groove is narrower and of a much rougher surface than in the right uninjured femur; while the surface over which the patella slides is not nearly so deep as that in the right femur, and this surface is roughened with numerous bumps and grooves. The surface of the entire distal end is much rougher and more porous, showing numerous foramina for blood vessels, more than in the case of the right femur.

The ligamentum teres is deeper on the right femur than on the left, on the latter it is comparatively shallow and broad. The insertion-scars of the gluteus medius, gluteus minimus and the pyriformis are of approximately the same size in both bones, yet in the left femur they are somewhat more sharply defined. The surface for the insertion of the gemellus inferior and the gluteus maximus has been reduced greatly in width in the injured element, although not noticeably in the proximal-distal dimensions. The trochanteric fossa of the left femur is not as

wide as the same in the right, thus reducing somewhat the surface for the insertion of the gemellus superior muscle.

There is a greater degree of change in the surface of origin of the vastus medialis muscle. In the right femur it has a decidedly medial to anterior position, covering a rounded ridge which extends from the neck to the shaft. In the left and injured member this ridge has become flattened and does not show, and the origin-surface it most distinctly anterior to

FIG. 1. ANTERIOR AND POSTERIOR VIEWS OF RIGHT FEMUR. × 1

medial. The lines of attachment of this muscle on the anterior surface of the lesser trochanter are more numerous than, and as deep as, those on the uninjured bone. The surface for the origin of the vastus lateralis muscle has become more truly lateral and perhaps shortened distally.

The line for the insertion of the caudofemoralis, presemimembranosus and the adductor femoris has changed considerably. The part for the insertion of the caudofemoralis is principally on the original shaft and although somewhat abbreviated distally it is yet very like that in the

right femur. The same is true for the insertion of the adductor longus muscle. It is the presemimembranosus and the adductor femoris muscles that have suffered most. A thin bony plate extending proximad from the proximal end and the lateral side of the distal part of the femur is perhaps the new insertion of the presemimembranosus. The adductor femoris having two surfaces of insertion normally, which are more or less at right angles to each other, now has a very much broader area of attachment, especially the more distal part of the insertion. And it is to be presumed that it is this powerful muscle that covered the peculiar, smooth and high, transverse arm of bone that clasps the distal end to

FIG. 2. ANTERIOR AND POSTERIOR VIEWS OF LEFT FEMUR. × 1

the main shaft. Also the muscle would have to function at a somewhat different angle than was normally the case. The play of the two bony parts on each other is like that of a knee joint, except that the range of movement is not as great.

The original fracture occurred through the insertion of the anterior semimembranosus on the medial and distal end of the femur. [The semimembranosus in the river otter is readily separated into two parts, the anterior part inserting on the femur and the posterior part on the tibia, the two tendons of insertion overlapping for a very small extent over the knee on the medial side.] The insertion of this muscle, judging

from the marks on the bone, has spread over the entire medial and distal end of the femur. The exact extent of the insertion-area of the semimembranosus is impossible to describe. The major injury to the leg, no doubt, caused increased activity in the muscle fibers in this region as well as in the bony tissue beneath it.

The surface of the bone along the injured edges is relatively smooth and in some places, especially along the posterior edges, it appears that there might have been some forward and backward movement between the two parts of the femur. A large cavity remains internally between the two osseous segments, this cavity opening anteriorly by a long diagonal hole, the posterior edges all touching and in one place overlapping by a long finger-like growth around the main shaft.

The measurements of the two femurs are as follows:

	Right *cm.*	Left *cm.*
Total length	9.15	7.30
Top width	2.82	2.73
Top depth	1.11	1.20
Mid-width	1.07	2.16
Mid-depth	0.86	1.42
Base width	2.79	3.95
Base depth	2.29	2.17
Great trochanter width	1.42	1.40
Great trochanter depth	1.48	1.50

The top depth is taken at the level of the lesser trochanter.

The accompaning illustrations will give a much more accurate idea of the extent of the fracture and the repair attempted than words.

GENERAL NOTES

AN ABNORMAL EAR IN LASIONYCTERIS NOCTIVAGANS

A specimen of *Lasionycteris noctivagans* taken in Syracuse, New York, in May, 1933, shows an abnormal ear. The right ear in this specimen is normal but in the left ear the tragus is united with the postero-ventral border of the auricle. There is no indication that this abnormality is the result of injury. The auricle is normal in shape and size and the union of the tragus and the auricle is smooth and complete. The normal shape of the tragus shows plainly as a thicker structure than the membrane uniting it with the main part of the ear. This specimen is in the Roosevelt Wild Life Station collection, accession number 11, at the New York State College of Forestry, Syracuse, New York.—Le Roy C. Stegeman, *N. Y. State College of Forestry, Syracuse, New York.*

WHAT ARE PROPER HIBERNATING CONDITIONS FOR BATS?

On November 9, 1926, I was notified that five bats had just been found behind a box that was resting on a window ledge (east exposure) of the Forestry building at Syracuse University. When I reached the scene I found the bats to be *Eptesicus fuscus*. They had already been disturbed and were lying huddled together on the stone sill. They appeared stiff and benumbed and made no attempts to fly or crawl about. I carried them to my office where they were kept for about four hours, whereupon I prepared to weigh them. They had by then become somewhat more active, but still did not attempt to fly. One of them, a little more lively than the rest, scrambled off the scales and fluttered feebly to the floor. The others remained drowsy and sluggish.

The weights of the bats were as follows: (1) a male, 18.5 grams; (2) a male, 20.4 grams; (3) a female, 18.5 grams; (4) a female, 19.7 grams; (5) a female, 21.6 grams. Aggregate weight, 98.6 grams.

With the intention of making some observations on the bats during their hibernation—which they apparently had already entered upon in conditions of their own choosing, behind the box on the window sill—I placed them in a small cigar box which had been provided with an aperture for ventilation and with a narrow shelf from which the bats could hang in a natural manner. A Fahrenheit thermometer was then hung inside the box and the whole placed in a dark unheated store room.

At more or less frequent intervals I looked into the box, took thermometer readings and noted the general condition of the bats.

Whenever I opened the box I found the bats hanging in a different position from that of the previous inspection, with respect to one another. A few examples of their arrangement may be mentioned: (1) The bats in two "layers," two in one and three in the other, hanging from the same section of the shelf; (2) four hanging abreast from the same section of the shelf, and one hanging alone on an adjacent wall; (3) in two separate groups, three in one and two in the other; (4) three hanging abreast on the same section of shelf, with the fourth bat clinging in a horizontal position across their backs, and the fifth hanging alone on an adjacent wall.

At each inspection the bats were slightly disturbed, and occasionally they would utter faint squeaks. When I touched them even gently they responded

with prompt, if rather feeble, starts. At no time were they in a truly dormant condition.

The temperature inside the box during the time that the bats were kept in the store room averaged a fraction more than 51 degrees Fahrenheit. The highest recorded temperature in this period was 57 degrees, on November 27; the lowest, 45 degrees, on Dec. 6. On only one other date did the temperature fall below 50 degrees, and that was on Dec. 30, when the reading was 48 degrees.

On Dec. 23, when the temperature in the box was 50 degrees, one of the females was found dead on the floor of the box.

On Dec. 30, the temperature in the box 48 degrees, one of the males was found dead.

The box with its contents was now removed to a room in which the temperature ranged between 67 and 70 degrees.

On Jan. 6 the two remaining females were found dead.

On Jan. 13 the last of the bats, a male, was still alive, but its responses were very feeble and it was apparent that it was dying. The next day it was found dead.

As soon as each bat was found dead it was weighed. At the time that the bats were first placed in the box I marked them for future identification, but these marks had somehow been removed in the course of their confinement, so that positive identification of the individuals was now not possible. The weights of the dead bats were, however, as follows, in the order in which they were found dead: (1) a female, 11.1 grams; (2) a male, 9.0 grams; (3) a female, 10.8 grams; (4) a female, 11.5 grams; (5) a male, 10.4 grams.

The aggregate weight of the dead bats was therefore 52.8 grams, as against their aggregate live weight of 98.6 grams when they were placed in the box on November 9.

Dissection showed the intestines to be free of any solid matter, but more or less distended with gas. For some time after the bats had been placed in the box a considerable number of droppings were found on its floor, but the whole amount was not sufficient to have represented any important part of their weight.

While the lowest temperatures recorded, namely, 45 and 48 degrees, may have been a factor in the death of the first two bats, it seems very doubtful that these temperatures had anything to do with those that died a week or two after they had been removed to a warmer room. In view of their loss of weight it seems certain that the bats actually died of starvation.

The place behind the box on the window ledge where these bats were first found, was one of their own selection. There is the question, of course, whether the bats had accidentally been overtaken here by cold weather, and their migration to milder parts thus interrupted, or whether they had chosen this place in which to hang up for the winter. In the latter case, could they have survived the winter in that situation in this latitude?

It is rather well known, I believe, that the big brown bat is not infrequently found in winter in this latitude, in central New York as well as elsewhere in the country, but usually within buildings to which it has had access, and it has not, so far as I am aware, been reported hibernating here in out-door situations.

If this bat is one that at times passes—or can pass—the winter in a state of dormancy approaching that of some of our other small mammals that normally pass the winter in such a state, then it is conceivable, perhaps, that my captives

were exposed to temperatures that were not too low but rather too high to enable them to survive; that their metabolic processes, because of the higher temperatures, went on at such a rate that the available food stores in their bodies gave out too soon. At lower temperatures the bats might possibly have reached a degree of torpidity that would have drawn upon their reserves less rapidly and they would have survived the winter. Their frequent changes of position in the cluster, previously mentioned, may, perhaps, have been merely an indication of a restlessness or activity that was abnormal, and which would not have been exhibited had the bats been in a truly dormant state.

Perhaps some reader of the Journal has tried to keep bats through the winter in the more northern parts of their range and can answer some of the questions here raised as to their requirements regarding temperature and other conditions necessary for them to survive.—CHARLES E. JOHNSON, *Roosevelt Wild Life Station, New York State College of Forestry, Syracuse, N. Y.*

CONCERNING A RECENT RECORD OF MUSTELA RIXOSA IN COLORADO

On page 70 of the February 1933 issue of this Journal, Mr. Ernest Thompson Seton recorded as *Mustela rixosa* a small mounted weasel examined by himself in the collection of Jonas Brothers, Denver taxidermists, who had obtained the specimen from a locality within the city limits, as related by Seton.

Sometime ago Jonas Brothers generously donated this specimen to the Colorado Museum, where it has since been dismounted and the skull which was fortunately included in the mount and which is only slightly damaged is thus rendered available for examination.

A year ago last April when this weasel came into the possession of Jonas Brothers it was described to me as having a black tip or pencil on the tail, and as received at the Museum it did indeed possess one, though obviously it was not a part of the original specimen and clearly had been supplied by the taxidermist. When the animal was dismounted for preservation as a specimen, this tip was not replaced, leaving the terminal portion of the tail with every appearance of having suffered accidental loss of part of its length. Consideration of this circumstance and of the fact that a no inconsiderable hiatus exists between the known ranges of the various forms of *Mustela rixosa* and Denver, the possibility that the specimen might represent *Mustela cicognanii leptus* (Merriam) from the neighboring mountains impelled me to send it to Dr. E. Raymond Hall of the Museum of Vertebrate Zoology for comparative study and positive identification. Dr. Hall has recently returned the specimen, and the following is quoted from his report under date of June 9, 1933:

"Comparison with specimens here shows the skull to be that of *Mustela cicognanii leptus* (Merriam) and not *Mustela rixosa* or any of its described subspecies as listed by Swenk (Journ. Mammalogy, vol. 7, no. 4, pp. 327-329). Inspection of the skin, in white winter pelage, clearly shows that the distal part of the tail has been lost. Probably it originally had a black tip. I have not noted any other features judged to be of specific worth which distinguish the skin from other Colorado-taken examples of *M. c. leptus*."

Mustela rixosa then is not yet entitled to a place in the state faunal-list.—F. W. MILLER, *The Colorado Museum of Natural History, Denver.*

FOURTH RECORD OF THE PRIBILOF FUR SEAL ON THE OREGON COAST

During the late afternoon tide of February 4, 1933, an immature male *Callorhinus alascanus* was washed ashore at Roads End, Lincoln County, Oregon. The specimen (no. 1981, coll. S. G. J.) was much emaciated and the stomach empty. It measured 860 millimeters from tip to tip. Previous records of this species taken in Oregon, as published in the Journal of Mammalogy, are February 1, 1921, February 28, 1925, and about mid-December, 1929. The only other definite evidence of the former occurrence of the Pribilof fur seal on or near shore in Oregon is from skeletal remains taken from the ancient shell mounds on the Tillamook County coast.—Stanley G. Jewett, *Portland, Oregon.*

THE STRIPED SPERMOPHILE IN FAIRFIELD COUNTY, OHIO

While trapping small mammals near Lancaster, Ohio, on April 6, 1929, I was surprised to find a colony of striped spermophiles (*Citellus tridecemlineatus*) inhabiting a hill pasture near town, in Section 32, Pleasant Township. I had been over this field many times before but had not seen or heard of the occurrence of this mammal in the county.

During April, 1929, I trapped four specimens, three females and one male, in this field and made study skins of them. I visited this field again in April, 1933, and obtained six additional specimens, three males and three females, from April 8 to 20.

Farther east in the county, in Sec. 4, Bern Tp., I collected two specimens on May 3 and 6, 1933, and a single specimen in Sec. 3, Bern Tp., on May 16. Specimens were seen in Sec. 20, Greenfield Tp., on April 19, 1933, and in Sec. 35, Greenfield Tp., on May 4.

The specimens collected were made into study skins and are now in the U. S. National Museum and the Ohio State Museum.

The striped spermophile seems to be well established in this county and has invaded the Glaciated Plateau Area in central Ohio. Further extension of its range to the east and north-east may be expected.—Robert Goslin, *Lancaster, Ohio.*

NEW NAME FOR SCIURUS MILLERI J. A. ALLEN

In looking over the catalogue of squirrels at the Museum of Comparative Zoölogy in Cambridge, I find that *Sciurus milleri* J. A. Allen (Bull. Amer. Mus. Nat. Hist., vol. 31, p. 91, April 19, 1912) is preoccupied by *Sciurus epomophorus milleri* Robinson and Wroughton (Journ. Fed. Malay States Mus., vol. 4, nos. 3–4, p. 233. November, 1911). This is an old-world form from Trang in the Siamese Malay States (west coast); Allen's squirrel comes from Cocal, western slope of the western Andes in Columbia. I can find no record of any other name having been suggested for the Colombian squirrel, and so, in recognition of the fact that this form was originally named for the collector, Leo F. Miller, I would propose *Sciurus leonis* as a substitute, designating the original specimen, American Museum No. 32511, adult female, skin and skull, as the type. Later, J. A. Allen in his revision of the South American Sciuridae, gave *Mesosciurus* the status of a full genus and made *milleri* Allen a subspecies of *gerrardi*. If, as is probable, it is equally permissible to consider *Mesosciurus* as a subgenus, the new name be-

comes *Sciurus (Mesosciurus) gerrardi leonis*.—Barbara Lawrence, *Museum of Comparative Zoology, Cambridge, Mass.*

A METHOD FOR DETERMINING THE PRESENCE OR ABSENCE OF SPINES IN POCKET-MICE

Some species of pocket-mice are not easily separated on skull characters alone, but are readily distinguishable by the presence or absence of spines. In *Perognathus intermedius* spines occur on the rump, while in *P. penicillatus*, a species occasionally found in the same habitats, there are no spines. Externally the presence or absence of spines distinguishes the two species. Often in young individuals or during molt the spines in *intermedius* are few or only partially developed, making it difficult to determine their presence. When the dry skins are placed in a light petroleum derivative the distinction between hairs and spines becomes very conspicuous, probably because of differences in light refraction.

The skins (round or flat) to be examined are placed in a pan and completely immersed in naphtha, gasoline, or Stoddard Solvent. We use Stoddard Solvent, which under various trade names is made by most petroleum refiners. The use of this product is desirable because of the low fire hazard.

None of the solutions mentioned will injure the skin or label or affect the color. They are in general use by the cleaners of delicate and valuable furs and clothing. The only action of the solution will be to remove grease and dirt, which is beneficial to the specimen.

In a light-colored form, as *intermedius* or *phasma*, the spines remain light in color when placed in the fluid, while the hairs in contrast appear dark. The spines usually can be seen at once when submerged in the liquid, but the contrast of spines and hairs is greatest when the pelage is saturated by an immersion of several hours. In *ater*, an extremely dark-colored form, the spines are dark in color. When first submerged the destinction between spines and hairs is slight; however, after the pelage is well soaked the contrast becomes greater because of an apparent darkening of the hairs.

The method described has also been found useful in bringing out different color tones in the pelage of small mammals. *Ammospermophilus harrisii harrisii* and *A. h. saxicola* differ only slightly in the color tone of the pelage, and some specimens are difficult to identify on color tone alone. By soaking in Stoddard Solvent definite differences in apparent color tone are clearly evident.

This method of determining certain external differences in small mammals has been used by us only in the cases cited above. It is possible that with modifications the procedure could be made useful in descriminating closely related forms of other species or genera.—Philip M. Blossom, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE GENERIC POSITION OF MUS PYRRHORHINUS WIED

The very distinct rodent discovered by Prince Maximilian in eastern Brazil and named in 1826 as *Mus pyrrhorhinus* is still very rare in collections. Among the few examples of it is an immature specimen received in 1925 by Field Museum from H. Snethlage, who collected it at Ibiapaba, Piauhy. This was promptly identified by its peculiar coloration and no particular attention was given to its skull at that time. Since then I have examined a fine adult of the species in the

British Museum from Lamarao, Bahia, and have made more careful comparison of the young example in Field Museum. That the species is quite unique is immediately obvious. A conspicuous character of the skull is found in the greatly enlarged audital bullae which are not approached by any species of *Oryzomys*, *Oecomys*, *Thomasomys*, or *Rhipidomys* known to me. In other characters, the skull is scarcely typical of any recognized genus and this, perhaps, accounts for the treatment the species has received from the two most recent authors to deal with it, one (Glydenstolpe, Man. Neotrop. Rodents, p. 24, 1932) placing it in *Oryzomys* and the other (Tate, Amer. Mus. Novit., no. 581, p. 4, 1932) stating that it is "apparently a true *Rhipidomys*."

In 1884 (P. Z. S., p. 448) Thomas referred *Mus pyrrhorhinus* to *Rhipidomys*, previous authors having placed it in the very inclusive *Hesperomys*. In 1886 (Ann. Mag. N. H. (5), vol. 18, p. 422) Thomas stated that it was a "member of the subgenus *Oryzomys*," but the specimens he supposed to represent it were later found to belong to a different species (i.e. *Thomasomys oenax*). In 1928 (Ann. Mag. N. H. (10), vol. 1, p. 154), however, with true *pyrrhorhinus* in hand, he pronounced it "a true *Oryzomys*."

In external characters, the species does not suggest *Rhipidomys*. The pelage is not especially soft, the general body color has the fine-lined effect so usual in *Oryzomys*, and the hind feet are relatively slender. The tail is uniformly dark-colored and pencilled less than in *Rhipidomys*, about as in *Oecomys*. The teeth are as in *Oecomys* and *Oryzomys*, the anterior elements of the first upper molar with only faint indication of a division. The parietals are ridged and the rostrum not elongated. The palate, however, is not typically oryzomyine and approaches that of *Thomasomys* and *Rhipidomys*. The mesopterygoid fossa is parallel-sided and extends forward to the middle of the last molars, but slight lateral pits somewhat intermediate in character are present. Such a palate may be found in some species of *Oecomys* and it appears also to be evident in the little known *Phaenomys*. The large audital bullae are unique. On the whole, it seems quite impossible to call it *Rhipidomys*, but it might be placed in *Oecomys*, at least until *Phaenomys* is represented by better material.—Wilfred H. Osgood, *Field Museum, Chicago.*

THE FLORIDA WOOD RAT IN THE MOUNTAINS OF GEORGIA AND NORTH CAROLINA—WITH A CORRECTION

Through an inexcusable error, I recorded[1] as *Neotoma pennsylvanica* a specimen of wood rat taken at Highlands, North Carolina, which on later examination proves to be *Neotoma floridana floridana*. Efforts have been made on several occasions since by Thomas D. Burleigh and myself to secure additional specimens at Highlands, but without success. On a recent trip in Georgia, I trapped another specimen of *floridana* very similar to the North Carolina specimen, at Neel Gap, base of Blood Mountain, at 3,100 feet altitude. These are the first specimens of any wood rat from the mountains of either North Carolina or Georgia and they extend considerably the known range of *Neotoma floridana*. The species is known from the coast region of Georgia and from many localities in Alabama, as

[1] Journ. Mamm., vol. 12, p. 168. May, 1931.

far north as the south side of the Tennessee River.[2] On Sand Mountain, in northeastern Alabama, it was taken at about 1,600 feet altitude, and on Choccolocco Mountain, near Anniston, Alabama, at 2,000 feet. The North Carolina record carries its range to 4,000 feet.

Comparing these two mountain specimens—neither of them fully adult—with comparable specimens of *floridana* from the lowlands, a slightly more grayish cast to the pelage, especially on the sides of the face, is noticeable, and the skulls have somewhat shallower rostra. A larger series may show these characters to be sufficiently constant to warrant recognition of the mountain form as a subspecies.—ARTHUR H. HOWELL, *U. S. Biological Survey, Washington, D. C.*

DERMESTID BEETLES AS AN AID IN CLEANING BONES

During the summer of 1922 opportunity was afforded the senior author to witness the speed and ease of preparing osteological specimens by employing dermestid beetles to remove the flesh. The work referred to was that of Dr. Remington Kellogg, then engaged in gathering a reference collection of skeletons of smaller vertebrates, for the Division of Food Habits Research of the U. S. Bureau of Biological Survey, as an aid in identifying items found among the contents of birds' stomachs. A few months later at the Kansas Museum of Natural History, under the direction of Mr. C. D. Bunker, opportunity was afforded actually to employ this method of bone preparation. As a result of this earlier experience, a certain amount of experimental work has been done during the past three years at the Museum of Vertebrate Zoology in the cleaning of osteological specimens. The aims were to develop a technique which (1) permitted greater speed of preparation, and (2) yielded a product of superior quality, with, of course, reduction to the minimum of the chances of "mix-ups." By combining two common methods of preparation, namely removing cooked flesh by means of instruments and exposing dried specimens to these beetles and their larvae, a system has been devised which we now feel justified in describing as possibly of help to others.

The beetles employed are dermestids of the species *Dermestes vulpinus*. A number of these sufficient to start a colony may be found on decaying carcasses of vertebrates, especially carcasses on which some or all of the meat has "dried up." Although a fair number of adult beetles is required in a working colony for reproduction purposes, the growing larvae consume, by far, the greater amount of food; the larvae are the most useful as bone cleaners.

Efficient use of these dermestids, hereinafter designated as "bugs," requires a room which is bug proof and which can be kept warm and at an even temperature. Such a room was incorporated in the new Life Sciences Building, at the University of California, housing the Museum of Vertebrate Zoology. Heat is provided by a steam radiator regulated by a thermostat so as to maintain a constant temperature of 84° Fahrenheit. A pan of water placed on the radiator provides the necessary humidity. The room, eight feet wide and ten feet long, opens into the preparator's laboratory. It has a concrete floor and ceiling, with hollow tile walls. The walls are provided with steel shelving, which supports wooden boxes three feet long, eighteen inches wide and one foot deep. It is in these boxes that the beetles are reared and allowed to work. A strip of tin, three inches wide, laid

[2] Howell, A. H., North Amer. Fauna No. 45, p. 52. 1932.

around the inside of each box at its top keeps the bugs more or less confined. The fresh carcass of a dog, or other animal of similar size, which has been skinned, drawn, and hung up until the surface of the meat has dried, is placed in the box. A few dozen adult beetles are put on the carcass and left for about a month. At the end of this time the bugs have greatly increased in number and have consumed most of their meat supply. Conditions then are at an optimum for their use as cleaners of specimens; a large number of larvae are concentrated in a small area where a diminishing food supply forces them to work on any new material introduced. By starting a new box every two weeks, a constant supply of bugs is maintained.

Everything now is ready for the actual process of skull or skeleton cleaning. The hard dry specimens as received from the field are ready to be placed in the bugroom one layer deep in shallow cardboard boxes with a thin piece of cotton beneath them and another layer covering them. The cotton provides a place for the larvae to pupate. These cardboard boxes then are placed in the boxes containing the bugs. Skeletons or broken skulls must be put in individual boxes to prevent the mixing of specimens. The time required by the bugs to clean small skulls usually is from 24 to 48 hours, depending upon the number of bugs and the amount of food remaining on the carcass used for nursery purposes.

After removing the skulls from the bug room the lower jaw of each is disarticulated and the skull, jaws and tag are put in a vial. Ammonia is added. The vial is corked and allowed to stand for twelve hours. The concentrated, 26 per cent, ammonia used will loosen any pieces of meat or cartilage overlooked by the bugs and will also remove excess grease in the bone. The ammonia is then replaced by water and the skull is allowed to soak twenty-four or more hours, depending on its size. After pouring off the water the skull is washed in a fine stream of warm water with a cross stream of compressed air. The worker sits at a table into the top of which a small sink, 14 inches long, 10 inches wide, and 6 inches deep has been set. Above this, connections to hot and cold water lines empty through one outlet to permit of regulating the temperature of the water discharged. A blowpipe, run through a rubber cork which is inserted in the nozzle of the faucet, provides a stream of small diameter, adjustable as to velocity. Another blowpipe, inserted in the end of a rubber hose connected with the compressed air line is so arranged that its outlet can be brought near the outlet for water. The rinsing in the air and water completes the cleaning operation. The specimens are placed in small pill boxes to dry, and after 24 hours they are bottled and then are ready to be sent to the cataloging room.

Comparison of specimens cleaned by cooking with those cleaned by bugs clearly shows the superiority of the bug process. However, there are certain precautions to be taken when using bugs; first, when material in a moistened condition is presented to the bugs, it is *imperative* that the tags be of parchment or water-resistant fiber composition and that the data be written with ink which will withstand submersion in water and ammonia. A tag of thin or soft paper will be defaced or entirely destroyed by the bugs. Second, the large porous tympanic bullae of such skulls as pocket mice often are filled with blood and are likely to be eaten by the bugs in the course of their endeavors to reach the blood. Skulls in this condition, and bones of very young individuals, should be dry when put in the bug room and should be exposed to a limited number of bugs.

When skulls are to be cooked, we have found it best first to soak them for twelve hours in a solution of water and ammonia (proportion, two quarts of water to one ounce of ammonia). Of course the young and broken specimens always are separated from the perfect adults. In cooking, one tablespoonful of mild soap flakes and 15 cc. of concentrated ammonia are used to two or three quarts of water. This solution is brought to near the boiling point and cooked ("simmered," not boiled) until the meat is soft and transparent. To remove the meat, a fine stream of compressed air is far superior to instruments or water. There are several reasons for this. One reason is that it is much faster. Also it is more thorough, and the loss of lachrymals and zygomatic arches is greatly reduced for the reason that these parts are more easily displaced by touch of an instrument than by the air. The air, strangely enough, does not blow off these fragile bones even when striking them with considerable force. One must be careful, however, to keep a finger over the teeth for there is danger of blowing them out in the case of these specimens which have been cooked.

Experience has led to the practice of cooking skeletons as large as those of deer, moose, and lion instead of "bugging" them. The cavities of large leg bones are filled with marrow which must be eliminated as soon as possible, to prevent it from soaking into the bones and staining them. If a small hole is drilled in each end of the bone, at the time of cooking, the water will loosen the marrow and it can be blown out with compressed air. Even though the skeleton may have been roughed out well, there is enough oil in the remaining meat thoroughly to soak the bone, if it be allowed to remain uncleaned for as long a time as is required by the bugs to clean it. The soaking of large skulls and skeletons in many changes of cold water will remove the blood. Although it usually is impossible to soak these in the field, opportunity should be taken to soak such specimens as arrive at the laboratory in a fresh condition. Never use water which is hot; this will set the blood in the bone. Where conditions permit, maceration of adult skeletons of large animals gives most satisfactory results.

In conclusion it can be said that, by use of the dermestids, one worker can clean, thoroughly and without the slightest damage to the most delicate processes, many times the number of specimens he can complete with any other known method. Processes are not broken off; delicate structures are not destroyed; teeth do not fall out; enough non-greasy animal matter remains in the bone to prevent deterioration; and sutures do not gape even in young specimens. All these are advantages over cooking. The preparator using this process may clean up to 100 and even 200 skulls a day. Also, the employment of compressed air as a substitute for instruments is an aid which cannot be too highly recommended.—E. Raymond Hall and Ward C. Russell, *Museum of Vertebrate Zoology, University of California.*

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COMMENT AND NEWS

BARTON WARREN EVERMANN

Dr. Barton Warren Evermann died at Berkeley, California, from pneumonia on September 27, 1932. He was born on a farm in Monroe County, Iowa, on October 24, 1853, the son of Nety Gardner and Andrew Evermann. On October 24, 1875, he married Meadie Hawkins at Burlington, Indiana. His interest in biological work was stimulated by David Starr Jordan, then president of Indiana University, and this association continued through the lives of both of these men. As professor of biology, Dr. Evermann taught in the Indiana State Normal School from 1886 to 1891. During this interval, he accepted a number of temporary assignments with the U. S. Bureau of Fisheries, but did not receive a regular appointment until 1891. Subsequently, Dr. Evermann held various positions in this bureau until 1914, when he became the director of the California Academy of Sciences, a position which he held until his death.

Dr. Evermann enriched biological sciences, especially ichthyology, through 387 published contributions, of which 30 dealt with mammals. He also contributed much to the study of conservation problems, a subject that he became actively interested in through his service as U. S. Fur Seal Commissioner in 1892. He afterward actively coöperated with George O. Shields, president of the League of American Sportsmen, in the general campaign for reasonable restrictions on hunting. While chief (1910–1914) of the Alaska Division, U. S. Bureau of Fisheries, he drafted the first definite regulations for the protection of fur-bearing land mammals in that Territory. From 1904 to 1914, Dr. Evermann was chairman of the Fur Seal Board. His outstanding contribution to conservation of mammals in California was the handling of the elk problem. In 1915, as the representative of the California Academy of Sciences, he participated with representatives from the California Game Commission in the transference and distribution of the valley elk (*Cervus nannodes*) to localities elsewhere in the same state.

Dr. Evermann's interest in the conservation of whales and other marine mammals led to his active participation on the boards of a number of organizations concerned with such matters, including the Pan-Pacific Scientific Congress, the Committee on Marine Mammals, American Society of Mammalogists (1921), chairman of the Committee on Conservation of Marine Life, Pacific Division, American Association for the Advancement of Science (1923), and the advisory board of the Council for the Conservation of Whales and other Marine Mammals under the auspices of the American Society of Mammalogists (1928). His interest in educational exhibits resulted in the erection of a splendid series of mounted groups of large mammals.

His body was cremated, and his ashes were buried in Burlington Cemetery, Burlington, Indiana, on October 22, 1932.—Remington Kellogg.

CHARLES WALLACE RICHMOND

Charles Wallace Richmond, one of the Founders of the American Society of Mammalogists, died at Washington, D. C., May 19, 1932, in the 64th year of his age. He was born at Kenosha, Wisconsin, Dec. 31, 1858, the eldest son of Edward

Leslie and Josephine Ellen (Henry) Richmond. When he was twelve years of age his mother died and shortly after, the family having removed to Washington, young Richmond became a page in the House of Representatives. At 15 he left school to become a messenger in the U. S. Geological Survey and later served as an assistant in the Biological Survey. On July 1, 1893, he secured a position in the U. S. National Museum; shortly after he became an assistant in the Division of Birds, and from 1918 to the time of his death he held the position of Associate Curator. He was appointed Curator of Birds on July 1, 1929, but a few weeks later he voluntarily relinquished this place to resume his former position. He received the degree of M. D. from Georgetown (D. C.) University in 1897 and on August 31 of the same year married Louise H. Seville, of Washington.

Richmond's field work in mammals was practically limited to incidental collecting during two trips that were primarily ornithological. The first was to Nicaragua in 1892, the second to Puerto Rico in 1900. In Nicaragua, where he secured a small but unusually valuable lot of mammals, one of his companions died of malaria and he himself suffered from a badly ulcerated tooth. In Puerto Rico he underwent a painful attack of dengue. These expeditions cured him of all desire for field service and his subsequent work was mainly confined to bibliography and nomenclature in which he became a past master. Among his discoveries was the rare volume containing the original description of *Clethrionomys*, the present generic name of the red-backed mouse. Richmond was always affable, generous, and ready to place at the disposal of any one his rich fund of information regarding dates, books, and nomenclature.—T. S. Palmer.

MEMBERSHIP

Anyone interested in any phase of mammalogy is eligible for membership in the American Society of Mammalogists, and if elected will receive the Society's official publication, the Journal of Mammalogy, quarterly. Name and address, with remittance of $3.00 for annual dues, may be sent to the Corresponding Secretary, or to any officer of the Society. Membership is dated from the nearest January, although formal election will not take place until the annual meeting of the Society following the receipt of application.

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